ROADS AND HIGHWAYS

DEVELOPMENT OF A REGIONAL TRANSPORTATION PLAN FOR THE GREATER TORONTO and HAMILTON AREA

FOR CONSULTATION

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A Message From the Chair

March, 2008

Rob MacIsaac
Chair, Metrolinx

Road congestion is a huge factor impacting our lives. We at Metrolinx totally understand the urgency behind addressing this issue. But let's be clear: we are never going to eliminate congestion entirely. The truth is, congestion is a characteristic of successful, prosperous cities.

Congestion is not the only issue with our road system. Roads, like transit, shape the way our communities grow and are designed. Over the last few decades, road expansion and the way we have designed our communities have conspired to create places where a car is a necessity of life. This has become a vicious circle requiring ever more roads and more places to store cars. At the same time, along with congestion, greenhouse gas emissions have grown, and air quality has gotten worse.

Metrolinx is in the process of developing a Regional Transportation Plan (RTP) — a vision and strategy for transportation in the urban area stretching from Hamilton across the City of Toronto and the four surrounding regional municipalities. Our focus is on improving all modes of transportation, so people have more choices, and better choices, when they make their travel decisions.

Naturally, even if public transit can be expected to play a much more important role, we fully recognize that the automobile will continue to be a significant — although hopefully less dominant way of getting around.

Yes, we want more people to take transit, walk and cycle — or even work from home. But we also want to make things better for those who still need to drive from place to place. Improving the way highways and roads function is the focus of this, the sixth in our series of Green Papers feeding into the RTP.

As with other components of the RTP, technology is an area we want to explore when it comes to highways and roads. For example, information systems — giving people real-time reports on their transportation options — could help shape travel decisions for both drivers and non-drivers.

Using technology to regulate traffic flow is another possible solution. "Ramp metering" for example is a system of on-ramp gates to limit the number of cars that can get on an expressway at any given time. By controlling the flow of merging vehicles, this system helps eliminate clogging, keeping all of the traffic moving at a good rate. While some drivers may have to wait to get on the highway, ultimately they get where they are going faster because they don't face bumper-to-bumper traffic along the way.

We are also interested in ways to plan, prioritize, design and fund roads in new and innovative ways as integrated, not separate, elements of a sustainable transportation system. This may mean designing roads that are beautiful as well as functional, provide a safe and attractive environment for bikes and pedestrians, and give transit vehicles the priority they need to effectively compete with cars.

We want to know what incentives or disincentives might help change driving habits. For instance, should road pricing, or tolls, be implemented, both to help pay for transportation improvements and manage traffic volumes? Would expanded High Occupancy Vehicle lanes convince more people to carpool? Do we need to restrict what kinds of vehicles can use certain roads at particular times of day? We are also looking for input on if and where roads and highways should be expanded, and the role Metrolinx, different levels of government, and the private sector should play in road and highway decisions.

We are very interested in these and other ideas, and we want to hear from as many people as possible about what they think will or will not work as we consider options for improving our highway and road network. The more input we get, the better we will be able to determine what approach to take, not just for highways and roads, but for every component of the RTP.

Ultimately, our goal is to do a better job of planning and funding infrastructure decisions, to make sure the transportation system is coordinated, seamless and sustainable across the region.

This is a tremendous opportunity, with tremendous benefits:

- We can make this a more liveable region by improving people's mobility and giving them more personal time;
- We can position our economy as a strong competitor on the world stage by making sure that businesses get their supplies and their products to market with ease; and
- We can protect and enhance our environment by reducing greenhouse gas emissions and reducing the impact of pollution on our air, water and land.

Achieving these benefits will not be easy. It is going to take leadership, planning, cooperation and determination. Most of all, it is going to take thoughtful consideration, based on realistic, pragmatic information.

That is why we need your input — to make sure our vision for this region's transportation system, including highways and roads, will meet your needs.

Thank you for taking the time to read and comment on this Green Paper. We look forward to receiving your views.

Rob MacIsaac
Chair, Metrolinx

Executive Summary 6

1. Introduction 1
1.1 The Road to Change 1
1.2 The Regional Transportation Plan 1
1.3 About This Paper 1
1.4 The Role of Roads and Highways in the RTP 2

2. Strategic Approach 8
2.1 Goals for the GTHA Road System 8
2.2 Key Objectives 10
2.3 Issues and Challenges 11
2.4 Trends 15

3. GTHA and International Experience and Best Practices 17

4. Taking Action 19
4.1 Alternative Approaches 19
4.2 Funding 23

5. Assessment of Alternatives: Which Way to Go? 27
5.1 Analysis Factors 27
5.2 Partnership and Collaboration 28

6. Concluding Remarks 30

Appendix A: Roads and Highways Best Practices 31
Best Practices for Arterial Roads and Regional Streets 31
Best Practices for Managing Capacity – Expressways 33
Best Practices for Road Pricing 38

Appendix B: Potential Initiatives 42

Appendix C: Photo Credits 44

Executive Summary

Context

Roads are the backbone of our region's transportation system. They are key to our economy and our quality of life. Our competitiveness relies on our ability to reach destinations quickly and conveniently, and residents depend on the road network to access employment, services, and recreation.

Congestion is threatening our competitiveness, and our reliance on cars and trucks poses other challenges, including rising emissions of greenhouse gas and increased health risks. Furthermore, too many of our residents lose their lives or become critically injured on the roads. We need to change the way roads are planned, maintained and utilized.

The *Growth Plan for the Greater Golden Horseshoe*, in concert with other provincial plans and the Provincial Policy Statement, sets out the provincial policies and strategic directions for roads to meet a more sustainable future. They are to be components of multi-modal transportation corridors in which transit and goods movement needs take priority over those of single occupant automobiles. The Greater Golden Horseshoe (GGH) transportation system is to be connected, balanced, sustainable, and multi-modal.

The Regional Transportation Plan

Metrolinx was established in 2006 by the province of Ontario to develop a Regional Transportation Plan (RTP) — a strategic, long-term vision for a coordinated transportation system across the entire region. The RTP will help guide infrastructure investment decisions and provide a blueprint for action.

This Green Paper is the sixth in a series of seven papers that will inform the RTP. It provides a framework for thinking about today's roads and highways system as part of an integrated and sustainable transportation system, and the implications of alternative strategies for the future.

Key Objectives

Roads and highways are elements of the overall transportation system and must thus be screened against the three pillars of people, environment and economy. From these overarching principles, a diverse set of objectives are proposed, ranging from improving the efficiency of the existing network, designing roads to accommodate transit, walking and cycling, and identifying sustainable and stable sources of funding.

Issues and Challenges

Beyond the very visible issue of congestion, a set of issues and challenges are discussed, including, among others, road network gaps, traffic incidents, and the impact of emissions. A variety of institutional barriers are also presented, such as the tendency to plan and design roads independent of a comprehensive land use planning framework, a history of maximizing vehicular traffic instead of accommodating other modes, and measuring capacity in terms of vehicles instead of people and freight.

Alternative Approaches

Three alternative futures are proposed. These alternatives are not mutually exclusive and it is reasonable to think that the road system in 2031 will have components of all three. Furthermore, they are not the only options available and other alternatives may emerge over the course of public consultation.

Each alternative is mapped to the three pillars of economy, environment and quality of life, and described in terms of its qualitative impact on Greater Toronto and Hamilton Area (GTHA) travellers and residents.

As part of the RTP, complementary initiatives in the areas of transit, land use, demand management, active transportation, and goods movement discussed in other papers will be synthesized with the road and highway alternatives to define a complete, integrated and comprehensive multi-modal transportation strategy for the GTHA.

Alternative #1 – Trends focuses on the following:

- Implementation of limited High Occupancy Vehicle (HOV) lanes, built through road widening, thus preserving vehicular capacity for general traffic;
- Limited transit priority continues — transit in HOV lanes, signal priority, queue jump for existing Bus Rapid Transit (BRT) systems;
- Tolling restricted to Highway 407; and
- Improved active transportation and pedestrian infrastructure focused around transit stations, mobility hubs and established communities.

Alternative #2 – Incremental focuses on the following:

- Further progress towards integrating the prioritization and design of roads and highways within a comprehensive transportation system, using a common set of criteria and funding tools;
- Increased HOV lanes designed to integrate transit from the outset, and improved regional coordination of an integrated network — more HOV lanes built from converting lanes;
- Increased facilities employing transportation pricing;
- Increased active transportation network connections, improving mobility and connectivity of local networks;
- Investigation of "clean air corridors", giving priority to active transportation on select routes on smog days; and
- Limited goods movement and delivery during peak periods.

Alternative #3 – Bold focuses on the following:

- Full integration of the prioritization and design of roads and highways within a comprehensive transportation system, using a common set of criteria and funding tools at all levels. At the local level and down to a single development, strategies would be identified to implement a balanced transportation system — a shift from traffic impact studies to true transportation impact studies;
- Concept of "complete streets" on local roads, increasing social space and improving safety through place-making and innovative shared-space techniques, such as "naked streets";
- Increased dedicated transit lanes, with high speed higher-order transit on regional roads/arterials, and improved flow of local transit on local roads;
- Comprehensive transportation pricing, incorporating time of use, degree of amenity provided by the infrastructure, parking use, Greenhouse Gas (GHG) and other emissions;
- Restrictions on goods movement and delivery in congested areas, combined with the use of urban distribution centres.

Funding

Tolling and road pricing make up a user-pay and pay-per-use approach to funding. This approach is gaining more widespread application in metropolitan regions around the world to finance new infrastructure, combat congestion and encourage smarter mobility patterns.

In an effort to identify and review a full range of potential financial tools and revenue sources as part of the process leading to an Investment Strategy, municipalities, the province and other stakeholders will be consulted to examine the benefits and disadvantages of road value pricing in the GTHA.

New Planning Approaches

The Environmental Assessment process facilitates choosing among alternatives that are designed to solve a particular transportation problem. Occasionally, the process examines performance against a "triple bottom line" (economic, environmental and social). However, more often the analysis of alternative road and highway improvements has focused on the traffic and design aspects of each option.

Road and highway planning, design, and operations in the GTHA will need to change in order to reflect new policy directions. A broader approach to analyzing alternative solutions must be part of the change.

Next Steps

Dramatic and effective change to the GTHA roads and highways cannot happen overnight. Change will occur through a series of gradual steps by many partners working collaboratively. Doing this means the strategy must engage and involve multiple stakeholders including the public, planning and design professionals, elected officials, governments and agencies, as well as representatives of civil society and industry. It is only through extensive dialogue that we will define what role roads and highways will play in the sustainable transportation system and society that we want.

WE WANT YOUR INPUT...

To participate in the Regional Transportation Plan consultations, please visit our website at:

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1 Introduction

1.1 The Road to Change

Roads are not only the backbone of our region's transportation system but also a pillar of our economy and quality of life. Our competitiveness relies on the continued ability to reach destinations quickly and conveniently, and residents depend on the road network to access employment, services and recreation.

Every day, we see evidence of a road system that is not working as intended — a congested, unmanageable, and inefficient network of major roads that slows buses and carpools instead of speeding them up, that provides limited options to avoid congestion, and that allows unimpeded access without accountability for causing delays.

Congestion not only threatens our competitiveness but our reliance on cars and trucks poses other challenges, including rising emissions of greenhouse gases (GHG) and increased health risks. Too many of our residents continue to lose their lives or become critically injured on the roads. It is therefore critical that we change the way roads are planned, maintained and utilized.

Making our roads more efficient and having a variety of transportation choices (auto, transit, cycling, walking) will encourage the use of more sustainable and higher-capacity modes of travel rather than the single-occupant automobile. Roads and highways must be integral considerations to the development of transit services and more sustainable land use patterns.

This change is part of the Regional Transportation Plan (RTP) for the Greater Toronto and Hamilton Area (GTHA) being developed by Metrolinx.

1.2 The Regional Transportation Plan

Metrolinx was created by the Government of Ontario to plan and deliver improved and comprehensive transportation for the Greater Toronto and Hamilton Area (GTHA). An immediate priority for Metrolinx is the creation of a Regional Transportation Plan (RTP) — a strategic, long-term vision for a coordinated transportation system across the entire region. The RTP will serve as a guideline for infrastructure investment decisions and a blueprint for action.

Development of the RTP includes a series of seven Green Papers as the basis of consultation on key topics including: sustainable transportation; mobility hubs; active transportation; transport demand management; moving goods and delivering services; roads and highways; and transit. These Green Papers will be followed by White Papers, then by a draft RTP. These documents will be posted on the Metrolinx website and the *Environmental Bill of Rights* Registry for interactive input from the public and stakeholders. Results from consultation with the public, stakeholders, advisory groups, Metrolinx staff and the Metrolinx Board of Directors will feed directly into the plan.

The draft RTP will emphasize balanced initiatives that ensure access by all residents and visitors to a full range of transportation choices across the metropolitan region. It will also provide a framework for transportation decisions at the local level by citizens, system users, transportation service providers and other stakeholders.

1.3 About This Paper

This Green Paper is the sixth in a series of seven papers that will inform the RTP. It provides a framework for thinking about today's roads and highways system within an integrated and sustainable transportation system, and the implications of alternative strategies for the future. Three incremental sets of options and interventions are proposed. The interventions range from developing more on-street active transportation infrastructure to introducing tolled facilities and dedicated transit routes. They are to be reviewed, refined, and assessed in terms of how well they reflect provincial policy direction for the future of the GTHA. There are, of course, other options available, which the final RTP will address.

Various options — and combinations of options — will be discussed and assessed throughout the RTP's development. These will form the basis of meaningful consultation with the public, stakeholders, advisory groups, and Metrolinx staff and its Board of Directors.

This paper begins by setting out the baseline conditions for roads and highways in the GTHA: their regional roles and functions relative to local and international ones; current issues and challenges; and relevant trends.

To help readers picture future possibilities, a selection of "best practices" from the GTHA and elsewhere is included (Appendix A).

Responding to issues and challenges, and building on best practices, alternative approaches are presented. Input provided by Metrolinx following their release will be important to the overall RTP. Readers are encouraged to

stretch their imaginations, and think about *"how would we be better off?"* under the alternative approaches to the future roads and highways of the GTHA.

Picture 2 : Canada's first motorway and one of its busiest: the Queen Elizabeth Way.

Picture 3 : Buses on arterial HOV lanes: Don Mills Road.

1.4 The Role of Roads and Highways in the RTP

1.4.1 OVERVIEW

The GTHA roads and highway system is the foundation of its transportation throughout the region and performs a range of functions. Local roads support communities and neighbourhoods. Commuters rely on cars, and goods movement through a larger regional system. Business and industry relies on faster and larger highways that allow for higher volumes of traffic and bigger trucks, far more than on any other mode. Two-thirds of Toronto area residents travel exclusively by car. [1] Even travellers who don't drive — those who use public transit, cycle, and walk — depend on the roads and highways that form a network across the GTHA.

Apart from their transportation function, roads and highways define urban form. The original road network laid out when a community is first developed changes very little over time. This grid and the design of streets and roads help to define the unique character of each community. In fact, much of the GTHA's road grid is based on John Graves Simcoe's survey work in the 1790s. Roads and highways can act as barriers within and between communities, but when they become main streets and parkways, for example, they become "special places", destinations in their own right.

The current road system reflects the goals and objectives set for it several decades ago. It is now widely recognized that the role and design of roads and highways must change if the GTHA is to remain competitive while supporting its residents' quality of life and a clean environment.

1.4.2 STRUCTURE AND FUNCTION OF THE GTHA ROAD AND HIGHWAY SYSTEM

The roadways in the GTHA are organized as a hierarchical framework, with their design intended to reflect their transportation role and function at different levels as illustrated in the following table:

1 From http://www.statcan.ca/english/freepub/11-008-XIE/2008001/article/10503-en.htm

Type			Vehicle Role and Function	Example
Controlled Access Highway	Toll Highway		High-speed, high-capacity intercity and interregional travel; toll rates can be set to maximize profit or throughput.	Hwy 407
	Conventional Divided Expressway	Core-Collector	High-speed, high-capacity intercity and interregional travel, with core lanes for longer distance trips and collectors for shorter distance trips and access / egress functions.	Hwys 401, 427
		Conventional	High-speed, high-capacity intercity and interregional travel.	QEW, Hwy 400
		Conventional with HOV [2] Lanes.	High-speed, high-capacity intercity and interregional travel, with certain lanes set aside to provide congestion-free travel for buses and carpools.	Hwys 403, 404
		Conventional with Bus Bypass Shoulders	High-speed, high-capacity intercity and interregional travel, with transit buses allowed to use some shoulder segments under certain conditions.	Hwy 403 (Mavis - Erin Mills)
	Urban Expressway		High-capacity intercity and interregional travel; operated by municipality.	Don Valley Parkway, Red Hill Valley Parkway

2 High Occupancy Vehicle (HOV) Lanes

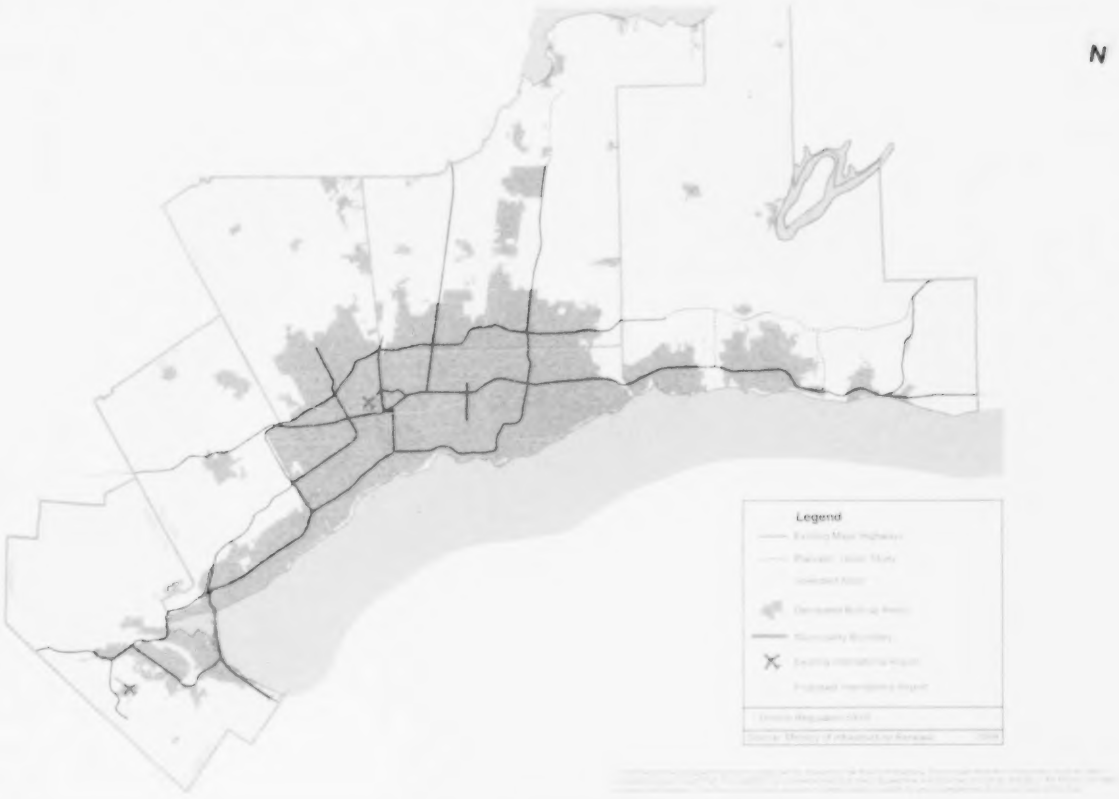
Type		Vehicle Role and Function	Example
Limited Access Arterial	Highway	Intercity and interregional travel.	Hwys 6 or 48
	High-Standard Urban Arterial	High-capacity, moderate speed with no direct access, to serve major traffic-generating areas and to provide intra-regional mobility and expressway access.	Highway 7 (part)
	Major Arterial	High-capacity, moderate speed with limited direct access, to serve major traffic-generating areas and to provide intra-regional mobility and expressway access.	Yonge St.
	Arterial with Integrated Transit	High-capacity, moderate speed with limited direct access, with dedicated full-time transit infrastructure.	St. Clair Ave., Queen St.
	Arterial with Bus / HOV lanes	High-capacity, moderate speed with limited direct access, with provisions for transit priority.	Eglinton Ave.
Minor Road	Collector Road	Carry traffic between local and arterial streets, and to provide access to adjacent properties.	Typical
	Local Street	Low-volume, low-speed route for traffic destined to or coming from adjacent property. Commercial vehicles and buses generally excluded.	Residential street
Other	Specialized Roads or Operating Regimes	Roads designed or operated for a site-specific or unusual purpose.	Jarvis St. Tidal Flow, private roadway, busway

Table 1 Structure and function of the GTHA road and highway system.

Expressways and other roads have a very different role within communities. While the sole purpose of expressways is to move large numbers of passengers and goods, and generally prohibit pedestrians and cyclists, other roads act as organizing elements in the urban fabric and must accommodate other modes of transportation, all competing for space and operating at different speeds.

The following maps show the major road and highway networks for the GTHA:

Map 1 : GTHA Major Road Network.



Map 2 : GTHA Expressway Network.

1.4.3 USE OF GTHA ROADS AND HIGHWAYS

The GTHA's roads and highways are used by almost every traveller in the region at some point. Even transit riders rely on streetcars and buses and buy goods inevitably delivered by truck.

Of the 2.5 daily trips taken, on average, by each GTHA resident, the vast majority use roads or road corridors. Subways and GO rail services only carry about five per cent of the GTHA's total daily travel demand; the rest of the 12 million-plus daily trips — by car, truck, bus, streetcar, bicycle, or foot — are focused on the road system (see chart, drawn from the 2001 Transportation Tomorrow Survey for the Greater Toronto Area). For residents of the rural areas of the GTHA, the regional road and highway network is key to their overall mobility.

The road system is not just important for its mobility function; about one in six jobs in the GTHA depends on the motor vehicle industry (including close to 400,000 jobs in the wholesale trade and transportation logistics sector alone), [3] so our economic health is directly tied to the state of the roads.

Roads shape and are shaped by land use, as noted by the Ministry of Transportation of Ontario (MTO), which outlined that "Most industries choose to locate their plants or distribution centres close to the major highways or rail network. Expansion and enhancement of the 400-series highway network has facilitated industrial development in Central Ontario that might otherwise have taken place in the U.S." [4] One consequence of this is that the GTHA road system must support more than one million truck trips per day and prepare for an expected 80 per cent increase in freight movement over the next 20 years. Managing and reducing congestion on the road network is essential if the goods movement sector is to support a vibrant GTHA economy.

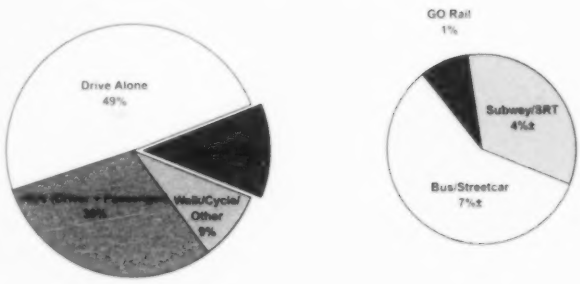


Figure 1 : Travel Mode for Total GTHA Person Trip.

Source: *Transportation Tomorrow Survey, 2001*

3 Development of Goods Movement Strategic Transportation Directions for Central Ontario, Ministry of Transportation of Ontario, December 2003

4 Ibid.

2 Strategic Approach

2.1 Goals for the GTHA Road System

2.1.1 THE GROWTH PLAN

The *Growth Plan* [1] sets forth the provincial policies and strategic directions on roads to meet a more sustainable future: they are to be components of multi-modal transportation corridors in which transit and goods movement needs take priority over those of single occupant automobiles. The transportation system is to be connected, balanced, sustainable, and multi-modal. There is a strong emphasis on goods movement; the *Growth Plan* states, *"The first priority of highway investment is to facilitate efficient goods movement by linking inter-modal facilities, international gateways, and communities within the GGH."* Similarly, on the transit front, the position is that *"Public transit will be the first priority for transportation infrastructure planning and major transportation investments."*

The transportation policies in the *Growth Plan* speak to, for example, identifying and protecting corridors to meet current and projected needs for various travel modes including highways and road (policy #3.2.2.3(a)). Therefore, it is implied that road widening and network expansion/completion could happen, given that all related *Growth Plan* policies (i.e. both land use and transportation policies) are satisfied.

From the provincial perspective, it is clear that it is not "business as usual" for the future of the roads and highways in the GTHA. This position fed into the wording of Section 6(2) of the *Greater Toronto Transportation Authority Act, 2006*, which specifically requires Metrolinx to:

> (b) make use of intelligent transportation systems and other innovative technologies;
> (f) promote the integration of local transit systems in the regional transportation area with each other and with the GO Transit system;
> (g) work towards easing congestion and commute times in the regional transportation area;
> (h) work towards reducing transportation-related emissions of smog precursors and greenhouse gases in the regional transportation area; and
> (i) promote transit-supportive development to increase transit ridership and must support the viability and optimization of transit infrastructure.

However, it will take some time to realign the policies and processes of the municipal, provincial, and private agencies responsible for planning and delivering transportation services in the GTHA to be in sync with the *Growth Plan* principles. The *Places to Grow Act, 2005*, requires all municipal Official Plans to conform to the *Growth Plan* by June, 2009.

It is particularly difficult for municipal road agencies to implement facilities with inter-regional intent, since that requires investing in infrastructure within a neighbouring jurisdiction. Meanwhile, there has historically been no regional-scale agency with a mandate to resolve these issues. This is why cross-boundary travel and infrastructure has periodically arisen as a contentious issue in the GTHA. A major role of the RTP will be to identify inter-regional transportation gaps and prioritize projects to resolve the associated problems.

Picture 4 : Are we there yet?

2.1.2 A COMPREHENSIVE APPROACH: THE THREE PILLARS

In providing alternative future strategies, the Paper reiterates the principles outlined in the province's Growth Plan — to plan for and accommodate future growth based on the needs of people, the environment, and the economy — and relates the alternatives to those principles. The future GTHA roads and highway strategy will be designed to implement with a broad range of provincial policy objectives, including the Growth Plan.

The three pillars of people, the environment, and the economy constitute the underlying foundation on which the RTP will be based. These dimensions are used to develop principles that inform each area of the plan. These principles for roads and highways are shown below.

1 *Places to Grow: Growth Plan for the Greater Golden Horseshoe*, Ministry of Public Infrastructure Renewal, 2006 Draft Report

REGIONAL GOALS	ROADS AND HIGHWAYS OBJECTIVES
People Create urban centres and neighbourhoods that are safe, accessible, interesting at the human scale, provide affordable housing and foster social inclusion while supporting sustainable transportation choices, including transit.	• Roads will continue to be the backbone of a GTHA transportation system and land use pattern that offers affordable mobility to all, by whatever mode they find most convenient (walking, cycling, taking transit, ride-sharing, or driving). • Travel will be a safer and more pleasant part of living and working in the GTHA than it is now. • Mobility will be maintained even for those who do not drive or who become disabled. Road corridors will accommodate getting around by foot, cycle, ride-sharing, or transit so more and more people become less auto dependent. • Road corridors will be restructured to shift personal travel decision-making so as to yield greater use of lower-impact modes of travel. • More efficient use of roads and less reliance on the private auto will reduce emissions and reduce the negative effect of poor air quality on personal health. Roads will be designed to maintain a human scale.
The Environment Improve our environment by measurably reducing the rates of urbanization of prime farmland, energy consumption, air pollution and greenhouse gas emissions, noise, accidents and related forms of neighbourhood disruption.	• With efficient design and operation of the GTHA road network and a variety of TDM programming, pressures for expanding into the natural environmental and agricultural areas will be reduced over a longer period of time. • Improvements in road operations will reduce vehicular emissions, improving air quality. Smoother traffic flow, higher persons-per-vehicle ratios, less drive-alone travel, reduced vehicle kilometres of travel per capita and more transit use will all contribute to reduced emissions from the transportation system.
The Economy Encourage and support a robust economy with steady, diverse economic growth supported by cost-effective public infrastructure and services, a highly educated workforce, and an urban ambiance that is attractive to viable enterprises and their workers.	• An efficient, accessible road network will help, rather than hinder, all those engaged in work and value creation in the GTHA. • Businesses will be able to locate and grow in places that are best for their function, rather than primarily on the suburban fringe. • Commuters will spend less money on transportation and less time travelling, thereby freeing up money and time for discretionary spending, more family or work time, and greater community involvement. • Better use will be made of land that would otherwise be occupied by roadworks and parking lots, yielding higher value to the community. • Improved air quality and improved road safety will reduce healthcare costs and mitigate the drag on the GTHA economy of transportation-related delays, illnesses, and injuries. The capital, operating and maintenance cost of the GTHA transportation system per capita will be reduced as less infrastructure per trip is required.

Table 2 : Regional Goals and Roads and Highways Objectives - The Three Lenses.

2.2 Key Objectives

The GTHA road system is a complex hierarchy of connections, nodes, modes, and organizational structures. Based on the overarching vision outlined above, more specific objectives regarding roads and highways in the GTHA could include the need to:

- Optimize the use of existing infrastructure to move people and goods while minimizing the need for expansion;
- Analyze, design and fund roads and highways as integrated elements of the transportation system;
- Accommodate a range of modes and users, including transit vehicles, pedestrians and cyclists maximize the capacity of that infrastructure;
- Provide a safe, pleasant, convenient, and attractive experience for all road users in the long term;
- Meet the long term needs of GTHA travellers and industries;
- Support provincial land use policies;
- Identify sustainable funding solutions and make roads and the transportation system more self-sufficient;
- Ensure there is consistency and co-ordination between municipal jurisdictions and with other service providers.
- Build and sustain public support for innovative transportation strategies and solutions; and
- Ensure that roads and the transportation system as a whole operate within the limits of ecosystems.

A dramatic shift in the way roads are planned and designed along with a major effort to educate and develop support from the public, will be fundamental to the ability to create a transportation system that meets our future needs and objectives.

To create a society within the next two decades that actively supports and uses transit, cycling, and walking to work, school, shop, and play as an equal choice to driving alone, will be a tremendous challenge. The resolve to do so must come from GTHA residents and workers themselves, supported by the best guidance, information, leadership, and inspiration (not to mention infrastructure and services) that the transportation agencies, service providers, developers, and elected officials can provide.

Goal-setting requires a realistic understanding of what GTHA travellers need, and how the choices they are offered allow them to make travel decisions that are efficient, sustainable, convenient, and have little impact on others. As outlined in other Green Papers, the effect of GTHA roads and highways on the "choice hierarchy" needs to be considered:

a. Is driving the only option, or could you walk or take the bus?
b. If you must drive, can you go with others, either on this trip or regular trips? Can you share the driving and use the carpool lot or the HOV lanes?
c. Do you need to drive all the way, or could you drive to transit or to the carpool lot?
d. Do you need to go now, or could you go when the traffic is lighter / tolls are lower / parking is cheaper?

Picture 5 : Careful management of highway performance is essential.

A freeway lane can carry upwards of 2,000 vehicles per hour while operating at the speed limit. Once vehicles bunch up and the speed drops to stop-and-go conditions, that same lane will only be moving 1,500 vehicles per hour. An increase in vehicle throughput of 30 to 50 per cent is possible if traffic conditions can be maintained at the speed limit. Ramp metering, full shoulders (so incidents can be pulled out of traffic lanes), access restrictions, tolls, quick response to incidents, truck restrictions, well-designed interchanges, and driver training and courtesy can all contribute to smooth, high-speed, and hence high-capacity operations. Careful management of lane performance is one reason HOV lanes and Reserved Bus Lanes can operate successfully.

2.3 Issues and Challenges

These are the issues drivers in the GTHA face every day. Congestion caused by gaps and choke points makes trips longer. Alternatives to driving are not always convenient or comfortable, reducing the choice available to travellers.

The percentage of people using transit has been declining for years, as has the rate of carpooling in the GTHA, while transportation agencies have, since 1995, been "unable" to create any busways or bus lanes, or more than a few kilometres of HOV lanes. The reasons given: "too controversial"; "too costly"; "too disruptive"; "environmental impact"; "not within our mandate"; and "no funding". Only in the past few years has there been enough funding to begin moving towards a more positive view.

These issues could lead one to conclude that the real barrier to progress is the lack of priority the public places on creating a more effective and sustainable transportation system. This, in turn, comes back to the point that the institutions, elected officials, transportation industry, and developers have been following – using design standards from the 1950s and accepting "normal" emission standards, for example – rather than leading with a new approach to urban transportation priorities.

Among the key objectives is to examine the challenges of our current road and highway network through the lenses of people, the environment, and the economy:

Challenges	Description	People	Environment	Economy
Congestion	Projections indicate that if we continue growing in the same way, congestion will get much worse.	Congestion steals time from sleep, family time and work.	Idling and stop and go traffic results in increased air pollution. However, resolving congestion can also foster more overall kilometres driven – "induced travel".	Congestion costs increase every year in wasted time and fuel for both passengers and commercial operations. Congestion also impacts the reliability of transit services.
Gaps	Gaps and bottlenecks exist throughout the region.	Gaps and bottlenecks result in congestion and longer trip times. They can also prevent efficient walking, cycling and transit use.	Longer trip times and distances produce more emissions than if more direct routes existed but can also reduce overall travel.	Gaps result in longer trip times and distances, as well as congestion.
Traffic incidents	Thousands of incidents occur on GTHA roads every year, resulting in death, injury and loss of property.	Incidents exact a high human cost in time, loss of life and quality of life for victims and their families not to mention the personal financial cost and loss of earning power.	Spills; effects on congestion.	Incidents have a high direct financial cost resulting from loss of property, injuries and casualties. Incidents magnify congestion.

Challenges	Description	People	Environment	Economy
Greenhouse gases (GHGs)	Transportation is responsible for about a third of GHG emissions and are rising fast.	Greenhouse gases are responsible for climate change, with significant costs in loss of life, injury and personal financial costs from extreme and unpredictable weather.	Climate change will directly impact the long-term viability of natural ecosystems, both locally and globally.	Climate change is expected to exact high costs due to adaptation, loss of ecosystems and generally, major economic disruption.
Air, soil and water quality	Vehicles produce NOx, SOx and particulate matter which can become an issue depending on location, traffic and weather conditions. Also: road salts, melters, tire dust, windshield washer fluid and other chemicals.	Growing incidence of cardio-respiratory diseases; link between polluted air and low birth weight; advisories limit freedom.	Impact on fauna and flora, e.g. "acid rain"; lower water quality.	Increase in sick days; negative impact on tourism.
Noise and other impacts	Heavy traffic creates undesirable environments.	Noise, vibrations and other nuisances lower quality of life.	Impact on fauna and flora.	Lower property values.
Urban sprawl	In conjunction with planning policies, road expansion can be a precursor of the physical expansion of cities.	More time spent in transportation, reduced access to green space (except at the edges).	Loss of farmland and open space.	Overall cost of maintaining roads and infrastructure associated with larger urban areas. Creation of auto-dependent areas, resulting in more demand for roads.

Table 3 : Key Transportation and Land Use Challenges.

2.3.1 NETWORK CHALLENGES

The effectiveness of any type of network is related to the ability of traffic to spread across it and use all of the available capacity in a balanced and efficient manner. A network that funnels all traffic into a single choke point without providing alternate options is ineffective. Offering a choice of modes, routes, and travel conditions is key to using the network infrastructure and services most efficiently.

The GTHA road system is comprehensive and largely complete. However, the gaps that do exist are quite noticeable; they have a disproportionate impact on the functionality of the transportation system. Gaps may consist of "missing links" between corridors, or physical or functional interruptions on a continuous route.

A key role for Metrolinx is to help the affected agencies work together and prioritize actions in order to fill the gaps in the regional transportation network.

Picture 6 : The GTHA road network is not quite complete.

The RTP will need to include criteria relating to each of its three lenses — people, the environment and the economy — to determine which gaps warrant "filling". There are many reasons why the road system may not be continuous, including:

- Physical obstacles (e.g. a large body of water or very rugged topography to cross);
- Environmental obstacles (e.g. a wetland or protected area to cross);
- Socioeconomic obstacles (e.g. an established community);
- Funding shortfall (e.g. lack of money to address a costly gap);
- Lack of demand (e.g. the cost of filling a gap exceeds the value to its potential users);
- Historic reasons (e.g. use of different survey baselines when laying out the original road and lot system in adjoining jurisdictions);
- Differences in user cost (e.g. a toll bridge may fill a gap yet, due to its cost, not be as attractive to users as a longer, more indirect non-tolled route);
- Jurisdictional problems (e.g. a solution for one municipality's problems lying in an adjacent municipality, or a discontinuity between municipal road and provincial expressway plans);
- Timing and prioritization (e.g. a gap that is intended to eventually be filled but remains a low priority relative to more pressing improvements);
- Administrative restrictions (e.g. the agency responsible for transit needing to resolve a gap in that mode by inducing a road agency to act on it);
- Community impact (e.g. restrictions on truck use of roads that pass through residential areas).

These gaps can occur in transit, HOV, and cycle / pedestrian path networks just as they do in the highway and road network. Classic GTHA examples include the discontinuity in north-south road plans at the Vaughan-Toronto and Markham-Toronto boundary (Steeles Avenue), the termination of Highway 400 (Black Creek Drive) and Allen Road at arterial intersections in Toronto, and the physically limited east-west transportation corridors between Durham and Toronto. There are dozens more, covering all eleven categories noted above.

Such gaps in the road system, and lack of connectivity between key roads and off-line Urban Growth Centres and/or transit hubs, also have a major impact on the ability to create and operate effective bus, HOV and cycling routes. Buses and streetcars (which carry more GTHA passengers than the subway and GO rail systems combined) are particularly vulnerable to the congestion, out-of-way travel, routing restrictions, and reliability problems that gaps in the road network create. These problems, in turn, suppress transit ridership and exacerbate the congestion related to our over-reliance on driving alone.

The variety of situations means that the resolution of problems caused by network gaps and other challenges requires varied and situation-specific solutions.

2.3.2 INSTITUTIONAL CHALLENGES

Responsibility for planning, funding and maintaining roads and highways is shared by the province and municipalities. Over the years, these activities have become so complex that very specialized expertise is called upon. This specialization, combined with dedicated sources of funding, can come at the expense of a broader perspective, as outlined in the following table.

INSTITUTIONAL CHALLENGES	
Roads in isolation of transportation	Roads and highways are often analyzed in isolation of a complete transportation solution. Funding sources for roads and highways tend to be more dedicated and stable than for other modes of transportation. The impact of road widenings on walking, cycling or transit use is usually not considered in detail.
Design	Roads are designed primarily for cars and trucks. Transit vehicles, walking and cycling are only considered sporadically. Expressways and wide highways create barriers through and between communities. Roads are more considered as "conveyance devices" than real places or destinations.
Level of service measurement	Bias to maintaining a high "level of service" leads to road expansion in isolation of other external costs and benefits. Roads are designed to maximize vehicular throughput as opposed to passenger or goods movement capacity. "Improvements" usually refer to vehicular capacity increases. Congestion is perceived as more undesirable than other consequences, for example of widening or expanding a road.
Lack of price signals	The use of roads and highways is usually free, which results in overuse, manifesting itself as congestion. The response is either to build more than what is actually needed, or due to financial restrictions, less than necessary.
Induced travel and competition with transit and other modes	New roads and road widenings can lead to new trips not considered before: residents moving further away or travelling more. When road capacity is expanded or maintained, other modes such as transit, walking and cycling strain to achieve a competitive advantage.
Deferred maintenance	Though safe, the GTHA's roads and bridges require significant rebuilding and maintenance.
Accident clearing practices	Accident clearing practices can be slow, resulting in extended congestion, with lasting effects.
Lack of technological take up	Technology is not used to its full potential, for example to advise drivers on optimal routing.

Table 4 : Institutional Challenges.

2.3.3 INTER-JURISDICTIONAL DISPUTE RESOLUTION

There are and will be a number of network and policy issues that have an impact across regional boundaries similar to the cross boundary gaps issue mentioned in the previous section. As part of the RTP there needs to be a dispute resolution mechanism developed that spells out the roles of the various agencies/jurisdictions involved.

2.4 Trends

The road system in the GTHA — indeed, the entire urban transportation system — has reached a stage that requires a new approach to planning, design and management. The arterial road network is mature, with only minor widenings and expansions left to build at the urban periphery, while the provincial highway system is similarly within sight of its "completion". Within the developed part of the GTHA, there are no corridors remaining for new roads, and little ability to widen, grade separate, or otherwise significantly expand operating capacity. Any improvements that have a major impact on capacity in a particular corridor tend to be very costly, difficult to construct, and hard to prioritize over other pressing investment needs. Toronto's Front Street Extension is one example of this.

Even if transportation demand management initiatives gain in popularity, the area's anticipated population, employment, economic, and socio-demographic changes will cause significant increase in travel demand within and through the GTHA. Roads and highways will experience additional pressure as a result of this growth, both from private vehicles and an expanded role for transit.

The future of the road and highway system in the GTHA will therefore need to involve innovative ways of responding to the mobility needs of GTHA residents and businesses while continuing to address social and environmental goals such as improved air quality, a high standard of safety, and equitable and affordable access.

Public policy changes and technological developments are underpinning a *new* road and highway strategy — one that allows the system to continue to accommodate growth in a safe and equitable manner: The public policy context in is quickly shifting. For example, global awareness and concern about the environmental impact of transport systems (particularly air quality and greenhouse gases) are high and not diminishing in importance. More locally, the *Growth Plan*, building on the provincial *Greenbelt Plan*, protects the valuable natural areas and agricultural lands that surround the GTHA. It does so by directing growth to existing built-up areas and designated greenfield areas that can best accommodate the expected growth. This is further supported by the Provincial Policy Statement which promotes efficient development patterns that optimize the use of land, resources and public investment in infrastructure and public service facilities.

An emerging response in our region and throughout the industrialized world has been to limit the growth of the road system and adopt measures to handle increased demand more innovatively, while increasing funding for transit. At the same time, transport-dependent economic growth, continued expansion of cross-border goods movement, and the lack of tolerance for congestion remain key policy drivers, triggering billion-dollar investments and expenditures by all levels of government and road users in the GTHA each year. Given the challenges at hand, it is imperative that this existing and significant public investment be channelled in a way that produces the most effective, and efficient long-term outcome, while being assessed and prioritized within a comprehensive approach to create a sustainable transportation system.

While technology of some sort has always been part of the road and highway system, there has been exponential growth in technological capabilities (as they affect road transport) in the past decade, and dramatic improvements continue to be planned. The dynamic nature of technological innovation makes it difficult to pinpoint specific commercial solutions to all of today's problems, but new technological solutions will likely be available to help resolve many present and future urban transportation problems. With headlines such as "Germany's satellite-based motorway truck toll monitoring system launched" and "Vehicle-following system moves vehicle platoons at 150 km/h" appearing, there are grounds for optimism regarding the potential for technology to contribute to a faster, safer, more efficient, and higher-capacity road transport system for the GTHA.

Cutting across the public policy and technological areas, of course, are uncertainties largely beyond the control of Metrolinx and local governments:

- The impact of fuel price level and volatility on urban transport;
- The full extent of the public's willingness to embrace lifestyle changes in their transportation routine;
- Preferences for housing types, their affordability, availability and location;
- The "breaking point" in terms of traffic congestion's impact on competitiveness in the GTHA;

- The future make-up of the GTHA's economy and the pattern of its goods movements requirements, for example in size and frequency;
- Federal immigration policies and internal migration patterns which directly affect population growth in the GTHA; and
- These uncertainties require that the road and highway system of the future, as well as the broader transportation system, incorporate a significant amount of flexibility to be prepared to accommodate and serve many different future possibilities.

3 GTHA and International Experience and Best Practices

The GTHA's roads and highways are designed to a high standard and compare favourably with the best international practices in terms of geometric design and operational safety. In fact, other jurisdictions use certain facilities (e.g. Highway 407 toll route) as benchmarks.

In recent years, transportation authorities around the world have continued to develop and implement innovative approaches to increase capacity creatively, improve safety, accommodate priority vehicles (including buses, carpools, and trucks), integrate roads with their surroundings, accommodate pedestrians and cyclists, as well as transform highways into multi-modal corridors, providing user information, and generating revenue to fund road improvements.

In Appendix A, a selection of local and international "best practices" in road design and operations are set out, where projects elsewhere have some relevance to the GTHA. This overview is intended to provide examples. These have been selected from facilities and projects that may be transferable, that have been created in similar socio-political environments, and that are practical and "real", not speculative. Their use here is for information only. This paper does not recommend that they should or should not be used in any particular GTHA situation.

Please note that best practices for incorporating pedestrians and cyclists in road design are discussed in detail in Green Paper #3 – *Active Transportation* and are not repeated here.

Getting More Out of Existing Infrastructure

Arterial roads provide the bulk of the GTHA's road capacity. They must serve many operational functions while being closely integrated into the land use and social fabric of the city. Intersections are critical functional elements of roads and streets. In most cases, the throughput capacity and safety of a surface roadway are defined by its intersections.

Always a concern, but now of growing importance, is the ability of public transit vehicles to move smoothly and reliably on major streets. The entire road network should be more supportive of active transportation (particularly cycling) than it traditionally has been. In the city, transit-oriented corridors generally correspond to pedestrian-oriented streets, so a focus on moving people translates into improved pedestrian conditions along streets and safer, more convenient access to transit stations (including across streets).

For the GTHA to get more value out of its arterial system, the focus will need to be on intersection operations, maximizing person-moving capacity (primarily through transit measures) and supporting active transportation.

National, provincial, and municipal geometric and operational road design standards currently in use in the GTHA are not all supportive or reflective of the opportunities described in this paper, nor do they all relate to the multi-modal, people-oriented policy thrust being put forth by Metrolinx and the province. It will be important to review, update, and modify current standards and practices to reflect 21st century policies, objectives, strategies, and innovations.

Picture 7 : This four lane collector in Hamilton was designed to the standards of the day (which have not changed), then had to be redesigned to accommodate two lanes of traffic, bicycle lanes and parking.

Complete Streets

Complete streets represent more than just a "best practice". They reflect a fundamental shift in how roads and planned and designed.

While the primary function of expressways is to move people and goods in vehicles, arterials and urban streets are capable of serving a greater variety of users, among whom motorists are not necessarily the first priority. The concept of "complete street" can help fulfil this objective

as "pedestrians, bicyclists, motorists, and bus riders of all ages and abilities are able to safely move along and across a complete street".[1]

Complete streets can include a variety of design features including road narrowing, on-street parking, bus bulges, bicycle lanes, re-striping, sidewalk expansion, streetscaping, raised crosswalks, pedestrian-friendly features (benches, parkettes, public art), speed limit reduction, truck restrictions, and diversion of through traffic. Some of these tools have been used to reshape conventional roads into "complete streets". Slowing motor vehicles down through traffic calming and road narrowing can create on-road space for non-motorized users. Using opportunities provided by water main repair, pavement rehabilitation, parking changes, redevelopment, or traffic diversion is often the key to transforming a street.

Regardless of the specific design features employed, the opportunity exists to consider most new and reconstructed roads as complete streets. However, given that the GTHA's roads have generally been built with auto movement as the primary function, their transformation into complete streets would require a significant commitment by the road authority, the surrounding community, street users, and developers to make the necessary changes and capitalize on them to create a vibrant, sustainable, improved urban environment that maintains a transportation function.

Existing standards and guidelines that were developed in the past need to be revised to reflect new "complete street" objectives. These new guidelines need to consider the urban context in which the road is situated, person and freight throughput (rather than vehicle throughput), life-cycle costing, and modal priorities, with particular attention paid to how those new objectives can be achieved by retrofitting existing road corridors.

Other examples are organized into three categories:

Arterial and Regional Roads – best practices that get more value out of the GTHA's arterial system, the focus will need to be on intersection operations, maximizing person-moving capacity (primarily through transit measures) and supporting active transportation. Examples include:

- "Tidal Flow" operations
- Contraflow lanes
- Intersections
- Continuous Flow intersections
- Diverging Diamond interchanges
- Roundabouts
- Streetcar / LRT treatments

Highway Capacity – best practices are aimed at a growing interest in "pushing the envelope" in terms of optimizing person throughput, improving safety, and making the best use of limited physical infrastructure. Examples include:

- Retrofitting additional capacity
- Reversible lanes
- Moveable barriers
- Driving on the shoulder
- High Occupancy Vehicle (HOV) systems
- Carpool parking / Park and Ride lots
- Speed enforcement
- Access restriction
- Land use integration
- Intelligent Transportation Systems (ITS)
- Truck lanes
- Active transportation
- Construction and maintenance

Road Pricing – Metrolinx is undertaking a separate study for an investment strategy, which will examine a range of possible stable and sustainable sources of funding to support the desired sustainable transportation system that residents of the region want.

Charging users for their use of infrastructure can be effective in managing demand, including shifting use to off-peak hours, or encouraging carpooling. This rationale is explained in more detail in Section 4.2 of this paper and in Green Paper #4 – *Transportation Demand Management*. Examples applied to roads include:

- Open road tolling
- Shadow tolling
- Variable pricing and dynamic tolling
- High Occupancy Toll (HOT) lanes and Managed lanes
- Truck tolling
- Fast and Intertwined Regular (FAIR) lanes
- Area-based congestion pricing / environmental pricing
- Distance-based pricing

1 Definition from www.completestreets.org

4 Taking Action

4.1 Alternative Approaches

As seen previously, issues and challenges related to the GTHA road network are multi-faceted, complex and inter-related. All indicators point to upward trends as a result of anticipated population increases, particularly if demand patterns continue unchanged.

There is no single solution to the issues facing the roads and highways network; an effective, sustainable, practical response requires the application of all available tools to:

- Manage the existing system to optimize its performance;
- Manage/reduce travel demand to match available system capacity, manage congestion and mitigate nuisances;
- Reconfigure the road system to encourage and facilitate modal choices that accommodate a significant growth in goods and passenger movement but do not result in a proportional increase in vehicular traffic; and
- Strategically increase the capacity of the road network.

These tools are all in use today, but indications are that "more of the same" will be an inadequate response to the congestion challenge of the future. This raises strategic questions as to what new tools can be used, how to improve the use of existing tools and what level of effort is required to yield the desired results. As seen previously, a more integrated approach is also needed to ensure that roads and highways are evaluated, prioritized, designed and funded as elements of a sustainable, integrated and comprehensive transportation system. This will require significant changes in governance, innovative design approaches, leadership and effective championing, as well as increased awareness among all players.

Underlying this assessment is the knowledge that transportation needs and functions are closely related to land use and more generally to urban form. Areas that rely solely on the automobile look and function very differently than areas that accommodate a more balanced transportation system. Since the very inception of cities, land use and transportation decisions have been intricately tied. This will not change. As the RTP is developed, the varying impact on land use of alternative transportation networks and policy packages will be evaluated.

Three different approaches to the GTHA's transportation future, with an emphasis on roads and highways, are proposed. They are not mutually exclusive, and it is reasonable to think that the road system in 2031 will have components of all three. Furthermore, they are not the only options available. Other alternatives may emerge over the course of consultation activities.

Complementary initiatives in the areas of transit, land use, demand management, active transportation, and goods movement will be combined with road and highway options to form a complete, integrated and comprehensive multi-modal transportation strategy for the GTHA.

4.1.1 ALTERNATIVE #1 – TREND

In this baseline option, roads and highways will continue to be improved and expanded on the basis of provincial and municipal Official Plans, so that the network and its function in 2031 would be similar to that of today. Some planned actions include:

- Implementation of limited HOV lanes, built through road widening, thus preserving vehicular capacity for general traffic;
- Limited transit priority continues — transit in HOV lanes, signal priority, queue jump for existing BRT systems;
- Tolling restricted to Highway 407; and
- Improved active transportation and pedestrian infrastructure, focused around transit stations, mobility hubs and established communities.

Among potential interventions, broader implementation of HOV lanes through widenings is planned by the Ontario Ministry of Transportation (MTO). This includes expansion onto more 400-series highways, as well as sections of the Queen Elizabeth Way (QEW). In addition to benefiting carpoolers, the increase in HOV lane infrastructure is expected to boost transit speed and reliability on the highway network.

In this future, there could be new travel corridors in the outer part of the GTHA (depending on the outcome of studies currently underway in the Niagara-GTA, GTA West, and 407 East). The potential exists for some new roads to be built as toll highways like the 407 ETR. There would be only minor changes to the existing 400-series highways within the urban area, while highways such as 401, 400, and 404 would be widened where physically possible, mostly to expand HOV use. There would be few new interchanges. Investment would continue to focus

on pavement, and structure rehabilitation and maintenance, with localized reconfiguration, and shoulders strengthening and widening for bus use.

Buses would use HOV lanes and be permitted to use highway shoulders as a matter of course. Carpool lots and Park and Ride facilities in provincial highway corridors would help link carpools, bus services, and HOV infrastructure in a way that would attract more commuters to shift from driving alone to higher-occupancy modes. Highway and transit agencies would coordinate priorities, pool funds, and co-operate in creating easily accessed transit hubs at key points in the GTHA transportation network. Combined with technological advances for roadways, such as transit signal priority and queue jumping lanes, there is further potential to address the network's efficiency by improving the flow of high-capacity vehicles. These advances are currently employed in a limited fashion, through specific transit systems.

Some major corridors would host separate transit lines, such as bus rapid transit (BRT) and light rapid transit (LRT), while some urban streets could be reconfigured to place greater priority on transit, pedestrian and bicycle uses. Through the introduction of active transportation elements into municipal transportation plans, there are some improvements planned for enhancing infrastructure, and better accommodating cyclists and pedestrians. These facility upgrades are generally focused around improving active transportation access in established communities and transit stations.

The arterial grid is already largely in place, so planned road improvements would focus on selected widenings in developing areas and on resolving a few lingering gaps in the network. The HOV lanes would be implemented on several municipal roads by widening. A few opportunities could also arise to link expressway and arterial HOV corridors. Overall, however, the HOV lane network would remain fragmented.

TREND SCENARIO – KEY BENEFITS	
People	• Decrease in travel times for carpooling and transit
Environment	• Improved safety for active transportation
Economy	• Reduction in congestion and improved air quality on arterials with HOV and transit improvements

Table 5 : Trend Scenario – Key Benefits.

4.1.2 ALTERNATIVE #2 – INCREMENTAL

A strong force to support transit is building momentum, and the GTHA road network is well-positioned to support this direction. In this alternative, an emphasis is placed on facilitating travel by transit and in HOVs. Options to achieve these changes include:

- Further progress towards integrating the prioritization and design of roads and highways within a comprehensive transportation system, using a common set of criteria and funding tools;
- Increased HOV lanes designed to integrate transit from the outset, and improved regional coordination for an integrated network — more HOV lanes built from converting lanes;
- Increased facilities employing transportation pricing;
- Increased active transportation network connections, improving mobility and connectivity of local networks;
- Investigation of "clean air corridors", giving priority to active transportation on select routes on smog days; and
- Limited goods movement and service delivery during peak periods.

Further interventions to improve the connectivity and efficiency of the road network across regional borders could include further development of HOV lanes, either through conversion of existing lanes or continued expansion on existing highways. Regional coordination would be necessary to ensure that discontinuities between local HOV lanes are minimized, resulting in a seamless network.

Wider application of Transportation Demand Management (TDM) programs, including the application of transportation pricing for select infrastructure and facilities, would begin to reduce congestion through the selection of alternative modes and a reduction in unnecessary trips. Similar demand management concepts could be applied to trucking and goods movement, with the introduction of controls on deliveries during peak periods in congested areas.

Interventions aimed at encouraging active transportation on the road network should expand to improve mobility between communities and transit stations — developing infrastructure for improved connectivity. A potential intervention to further decrease air pollution in severely congested areas would be the introduction of "clean air corridors", which give priority to active transportation and transit on select urban routes during smog days.

The critical issue is not the physical ability to create transit / HOV priority measures on a significant amount of the GTHA's road network. It is the creation and sustainability of the public's support for this approach to the allocation of scarce road space. Shifting trips out of peak periods, telecommuting more, limiting the use of commercial vehicles in certain places and at certain times, cutting out discretionary travel, eliminating free parking, cycling and walking more, and spreading vehicular traffic throughout the network would all contribute to the ability to reallocate existing road space to transit, HOV, and bike use.

INCREMENTAL SCENARIO – KEY BENEFITS	
People	• Decrease in travel times across comprehensive HOV network • Increase in reliability of transit across network • Improved safety for active transportation
Environment	• Reduction in smog and GHGs • Reduction of use of heavy trucks during most congested periods
Economy	• Reduction in need to expand roadways by making more efficient use of existing infrastructure • Reduction in healthcare and infrastructure costs related to increased priority for active transportation

Table 6 : Incremental Scenario – Key Benefits.

4.1.3 ALTERNATIVE #3 – BOLD

A variety of more ambitious and progressive interventions could more radically transform the way in which roads and highways form the core of the region's transportation system:

- Full integration of the prioritization and design of roads and highways within a comprehensive transportation system, using a common set of criteria and funding tools at all levels. At the local level and down to a single development, strategies would be identified to implement a balanced transportation system — a shift from traffic impact studies to true transportation impact studies;
- Concept of "complete streets" on local roads, increasing social space and improving safety through place-making and innovative shared-space techniques, such as "naked streets";
- Increased dedicated transit lanes, with high-speed higher-order transit on regional roads/arterials, and improved flow of local transit on local roads;

- Comprehensive transportation pricing, incorporating time of use, degree of amenity provided by the infrastructure, parking use, GHG and other emissions; and
- Restrictions on goods movement and service delivery in congested areas, combined with use of urban distribution centres.

To further improve the efficiency of the existing infrastructure, greater priority would be given to transit, by way of more dedicated transit lanes, provisions for higher-order transit on regional roads/arterials, and improved flow of local transit on local roads through design (such as bus bulges and parking bays). New restrictions on goods movement and service delivery in severely congested areas, combined with the use of urban distribution centres, would facilitate the delivery of goods and services without compromising the region's need to move goods efficiently.

The application of a comprehensive transportation pricing strategy, as part of a suite of TDM programs, could incorporate a range of factors: time of travel; level of road and highway infrastructure; use of parking facilities; and GHG emissions. Creating a valued transportation system would be assisted by the targeted application of incentives and disincentives to direct land use planning to the creation of mobility hubs and to support provincial policy, including development charges.

On a local scale, innovative streetscape design and traffic management would help to increase the idea of roads as a destination, as well as a means of passage. There is inherent value in the social aspect of streets, and neighbourhoods would benefit from improved safety through place-making and innovative shared-space techniques, such as the removal of traffic signals and signs (frequently referred to as "naked streets").

Having many travel options and other financial incentives to travel in ways beyond driving alone is the key to a "mode neutral" transportation system.

BOLD SCENARIO – KEY BENEFITS	
People	• Decrease in travel times and increase in reliability of all modes • Improved connectivity across the transportation system • Contribution to safer, more people-friendly neighbourhoods • Reduction in accidents and fatalities
Environment	• Reduction in smog and GHGs • Reduction of use of heavy trucks in most congested areas • Reduction in environmental footprint, as fewer roads require widening
Economy	• Reduction in need to expand roadways by making more efficient use of existing infrastructure • Reduction in healthcare and infrastructure costs related to increased priority for active transportation • Increase in reliability and efficiency for moving goods and workers across the region • Enhancement of land values by creating safe, accessible, vibrant mixed-use neighbourhoods • Promotion of the most efficient use of infrastructure

Table 7 : Bold Scenario – Key Benefits.

4.2 Funding

4.2.1 ROAD VALUE PRICING

Tolling and road pricing make up a user-pay and pay-per-use approach. This approach is in limited application in the GTHA (407 Electronic Toll Route), but is gaining more widespread application in metropolitan regions around the world to finance new infrastructure, combat congestion and encourage smarter mobility patterns.

The current leading practitioners of area-wide and cordon-based congestion pricing include London, Milan, Singapore, Stockholm, and in the near future, possibly Los Angeles, Montreal and New York City.

In an effort to identify and review a full range of potential financial tools and revenue sources, as part of the process leading to an Investment Strategy, municipalities, the province and other stakeholders should be consulted to examine the benefits and disadvantages of road value pricing in the GTHA.

The objectives of a road value pricing study are multi-dimensional and extend beyond the Investment Strategy to other aspects of the Metrolinx and RTP mandates:

OBJECTIVE	BENEFITS OF VALUE PRICING
Investment Strategy	• New dedicated revenue generation to build and support a sustainable, multi-modal transportation system, including transit alternatives to highways and roads • Deferred need for "free" lane widening and highway expansion
Customer Service	• Faster, more reliable trip times: opportunity to bypass highway and road congestion pinchpoints subject to toll
Transportation Demand Management and Capacity Optimization	• Fewer and shorter trips • Modal shift from single occupancy autos to ride-share • Shifting trips from peak to non-peak periods
Transit	• Modal shift from single occupancy autos to transit
Broader policy objectives	• Faster-moving strategic trade corridors • Vehicle emission reduction – cleaner air

Table 8 : Benefits of Value Pricing.

The study terms of reference will examine the five key categories of road value pricing:

Area-wide pricing – Charges are applied on the basis of total distance travelled on all roads across the metropolitan region. This application relies on advanced Geographic Positioning System (GPS) and transponder technologies, and is capable of varying the charges by real-time congestion levels, route selection and time of day.

Cordon pricing – Charges are applied to motorists when they enter a designated congested area or cordon point. These systems can charge either a fixed or variable fee, and can be implemented using transponder and camera systems.

Tolls on individual highway and corridors – Specific routes can be tolled using rates that vary by time of day or dynamically with traffic conditions.

Toll lanes – Tolls are applied only on single or multiple lanes within the highway corridor, which also includes "free" alternative lanes. These toll lanes take the form of congestion-free express lanes or High-Occupancy Toll (HOT) lanes where solo drivers can pay a toll to use the HOV lanes.

Vehicle use pricing – Pay-per-use tools can include pay-as-you-drive per-kilometre vehicle use and insurance charge, mandatory parking fees for all on-street and off-street parking in commercial and residential zones, vehicle impact fees to cover the economic, environmental and social costs of vehicle use and parking.

Financial Empowerment Evaluation Criteria

The Investment Strategy will identify criteria for evaluating the effectiveness of the proposed financing tools and revenue sources in meeting the objectives for an integrated, sustainable transportation system in the GTHA:

EVALUATION CRITERIA	KEY RATIONALE
Flexibility to apply funding across two or more transportation modes	• Promotes integrated, multi-modal transportation solutions • Adds flexibility to apply funding and revenue source to capital and operating needs
Economic efficiency	• Promotes smart, real-time transportation choices by customers • Promotes infrastructure capacity optimization through market-responsive pricing • Preserves and strengthens the international competitiveness of our metropolitan region
Growth Plan objectives for our metropolitan region	• Promotes investment in transportation infrastructure to support Urban Growth Centre (UGC) formation and intensification within the existing urban boundary area
Regional distribution and equity	• Ensures that funding and revenue sources are primarily generated by users, beneficiaries and taxpayers within the GTHA metropolitan region
Stable long-term funding with no fluctuations in year-to-year funding levels	• Promotes sound long-term planning outlooks, financing and transportation asset management strategies • Aligns funding and revenue stream growth with regional economic and population growth, and resilient to economic and business cycle vagaries
Administrative cost	• Provides relative low-cost, ease and technological capacity in collecting, allocating and being accountable for the funding or revenue source

Table 9 : Financial Empowerment Evaluation Criteria.

4.2.2 COMPARISON OF ALTERNATE APPROACHES

To understand the differences between the three scenarios described above, the following table provides a snapshot of how each scenario would look to the user or to the GTHA resident circa 2031:

NETWORK COMPONENT	ALTERNATIVE		
	TREND	INCREMENTAL	BOLD
Provincial Highways	Increased user information; HOV lanes in select corridors; transit priority implemented in a limited fashion	Select facilities use transportation pricing; HOV lanes and bus lanes ubiquitous	Pricing and travel time information posted at highway entry points; smooth operation with limited congestion; speedy incident management; reliable travel times; comprehensive network of dedicated HOV lanes including dedicated HOV/interchange ramps and transit corridors
Regional Roads/Arterials	Increased user information; transit priority implemented in a limited fashion	Improved real-time information and incident management; substantial HOV and transit priority	Speedy incident management; reliable travel times; comprehensive network of feeder transit and HOV lanes
Local Streets	Similar to today, with bus lanes and with median streetcars in selected arterials	Priority measures for buses and carpools are common (dedicated lanes, special turn lanes); some urban streets reconfigured for multiple users	Streetscape and design accommodates all modes; majority favour active transportation; cars are equal choice; frequent and convenient transit service
New Roads	New travel corridors under consideration in Niagara-GTA, GTA West, 407 East extension, 404 north extensions; arterial grid completed where physically feasible	Limited number of new roads to fill network gaps	Fewer new roads; new roads built with pre-determined measures to manage demand; key network gaps filled

Table 10 : Comparison of Alternative Approaches – Network.

Each alternative will have a different impact on the multitude of users of the road and highway network:

USERS AND DIMENSIONS	ALTERNATIVE		
	TREND	INCREMENTAL	BOLD
Drive alone Commuters	Severe and growing congestion.	Severe congestion.	Managed and stable congestion; the extent to which it can be avoided will be reflected in price.
Public Transit Users	Busways, LRT, and bus lanes in many key corridors; on-street services still caught in congestion.	Enjoy fast, frequent service on dedicated facilities in most main corridors; emphasis on stations.	Good mobility and service with little delay; comparable to auto use in terms of travel time but lower cost.
Carpoolers	Use of HOV lanes and area-wide ride-matching services; some support programs.	HOV lanes and direct ramps provide free-flow HOV conditions in most major corridors during peak periods.	Good travelling conditions in mixed flow; most tolls incurred while carpooling automatically rebated or reduced.
Commercial Vehicle Movement	Incentives and provisions to travel at off-peak times.	Similar to Trend, plus truck-only facilities on approaches to goods hubs.	Trucks directed to key routes/times by pricing triggers, truck-only facilities on approach to goods hubs.
Cyclists	More bike paths and on-street bike lanes; improved access to transit hubs and bike-on-transit is the norm.	Building on Trend; more regional integration and connections to transit stations with storage facilities; some encouragement from employers.	Cycling facilities systematically integrated in road design and retrofitted in existing rights-of-way to form an integrated regional network. Comprehensive planning and more funds for bike facilities in public and private (e.g. workplaces) spaces.
Pedestrians	Limited localized initiatives; not viewed as fully part of "transportation".	Improved/streamlined municipal process for installing sidewalks on existing roads; growth in comprehensive pedestrian strategies.	Sidewalks on both sides of the roads, overlay pathway network in suburban areas; generalization of comprehensive pedestrian strategies, including a prevalence of children walking to school.
TDM	Growth in transportation demand management plans; more employer involvement.	Mandatory involvement of large employers in TDM; carpool parking priority and subsidized transit passes are the norm; more funding for TDM plans as part of new infrastructure.	Real-time information on travel conditions / prices / advice for all modes is ubiquitous; broad set of mandatory support measures; generalization of TDM plans for new developments and new transportation facilities.

Table 11 : Comparison of Alternative Approaches – User and Dimensions.

5 Assessment of Alternatives: Which Way to Go?

Choosing the right combination of actions and investments involves difficult choices. How much change are stakeholders, including governments, industry and the public, willing to accept? Are we ready to embrace new technologies, even if they require us to change our behaviour? More fundamentally, how can we use these decisions to help create more liveable and complete communities?

The RTP will compile the best features of all available alternatives (including the three options described here and other strategies to emerge through the consultation process) to create an integrated, comprehensive transportation strategy for the GTHA. The road and highway alternatives will be considered in conjunction with options emerging from the mobility hubs, active transportation, demand management, goods movement and transit streams.

5.1 Analysis Factors

Planning for roads and highways in the GTHA has always involved choosing among options. Environmental Assessment (EA) is a tool which can assist a proponent to make choices intended to address opportunities or problems. The EA requires a proponent to systematically evaluate the potential environmental effects associated with a project, both those which are good and those which are bad, among a reasonable range of alternatives. Following that evaluation, a preferred alternative is selected. In selecting the preferred alternative, the proponent is required to carefully consider whether it addresses the opportunity or problem for which the choice is being made, and balance that choice against potential environmental risks evaluated on an ecosystem basis. If there are adverse environmental effects, the proponent is also required to identify measures to mitigate or manage those effects. All EAs follow the same process. In that way, we evaluate performance and effects against the "triple bottom line" (economic, environmental and social) which is the basis for the planning approach which Metrolinx has adopted.

The analysis of alternative road and highway improvements has traditionally focused on the traffic and design aspects of each option. In the past, most road improvement studies were project-specific and were limited in scale. They only dealt with problems within a defined study area, focusing on the physical, modal, and jurisdictional scope of the proposed project. Increasingly, EA Master Plans and Strategic Environmental Assessments (SEAs) are being used to consider complex opportunities and problems at a regional level. The studies to which they give rise are intended to be holistic, taking into account the integrated and interdependent regional environment in which transportation projects occur. The RTP is a Transportation Master Plan. Its purpose is to identify inter-regional road, highway, transit, goods movement and active transportation opportunities and needs, and the infrastructure requirements and policies which are needed for them.

If, as outlined, road and highway planning, design, and operations in the GTHA need to change in order to reflect today's policy directions, the approach to analyzing alternative solutions must be part of the change. Metrolinx is leading the way in this regard. The statement of the opportunities and problems, which are the basis of the RTP, allow a range of reasonable solutions to be developed on an equal footing, at the regional level. Transportation questions are resolved, with an appropriate consideration of environmental effects and an emphasis on addressing mobility needs, as opposed to resolving a narrower traffic question with an emphasis on vehicular throughput.

For example, as a road study proceeds through the analysis and evaluation process, the factors used to compare options and rationalize the preferred solution must directly tie back to provincial policies; each project should be shown to conform to the *Growth Plan*, and potentially to the RTP.

5.2 Partnership and Collaboration

Dramatic and effective change to the GTHA roads and highways cannot occur overnight. Change will take place through a series of gradual steps by many partners working collaboratively. Doing this means the strategy must engage and involve:

The Public

- To become more knowledgeable of the impacts of their daily travel choices and how these choices impact our overall economy, environment and quality of life
- To become champions of change and make more responsible travel choices

Transportation Planning and Design Professionals

- To understand and study the application of road pricing in the GTHA
- To develop new guidelines, techniques, and design standards to better integrate various modes and priorities
- To reassess current facilities and plans in light of multiple and complex objectives
- To analyze, plan and design elements of the transportation system within the context of an integrated, comprehensive and sustainable transportation system — doing away with remaining "silos"
- To resolve the technical issues associated with new technologies, retrofitting the existing system and implementing it in a staged and rational manner
- To develop and begin to implement the infrastructure, systems, and programs that build towards a viable staged rollout of transit, HOV, and road pricing measures (e.g. invest in active transportation facilities, carpool systems, HOV and managed lane infrastructure, rapid transit, etc.)

Elected Officials

- To take responsibility for and assume leadership in understanding, shaping, promoting, and implementing a different approach to transportation in the GTHA
- To communicate the need and rationale for the road pricing vision to the general public, and to respond to questions and concerns
- To set out a long-term and stable administrative and legal structure (i.e. that will outlast political shifts and finite terms of office) in which to embed road pricing as a viable strategy in the GTHA urban plan
- To reassess GTHA priorities as they relate to transportation funding, investment strategy, and functions
- To link the transportation strategy to "whole of government" policies and actions
- To commit the necessary funds (including revenues from pricing) to create the infrastructure and programs that make a new roads and highways vision feasible
- To resolve jurisdictional and funding issues that prevent the implementation of functional solutions to long-standing problems

Industry

- To develop a workable, cost-effective, implementable, robust, reliable, comprehensive technological response to the stated vision
- To seek out opportunities for staged implementation, demonstration projects, and integrated solutions
- To begin to embed the necessary technologies in all new vehicles and to provide aftermarket retrofit kits for current vehicles
- To use ITS tools to optimize commercial vehicle routing and time of travel
- To prepare and implement TDM for passenger travel

GTHA Transportation Agencies

- To engage and establish a dialogue with all stakeholders — from auto insurance companies to the federal government
- To make a significant and ongoing effort to support and promote private shared-ride travel
- To build up the transit presence on highways and major arterials, and to provide the infrastructure within those corridors that will allow transit to compete equitably with auto travel
- To assess the need to fill strategic gaps in the road network within the context of the overall transportation system, considering all possible alternatives
- To create and make available real-time operational information (congestion, weather, price, transit service, ride-matching) that will allow GTHA

travellers and service providers to make informed choices as to how, when, and where they travel

- To introduce differentially-priced transit services, from basic / regular to premium / express, as a demonstration of transportation pricing in practice
- To introduce pilot pricing projects, such as Managed Lanes, parking pricing (including rates that vary by time of day and location within the lot), and local area congestion pricing
- To work to integrate road and highway strategies with other components of the GTHA plan, including land use, development planning, transit infrastructure, active transportation, goods movement, and funding
- To develop and implement financing, zoning, land use planning, and partnership schemes that promote greater integration between land use and transportation
- To study a range of reasonable and feasible alternatives transportation solutions, within the context of the overall transportation system, taking into account the three "pillars" of the RTP which are people, the environment and the economy.
- To develop a cross jurisdictional dispute resolution policy that will provide guidance and a mechanism to assist Metrolinx in resolving most, if not all, contentious transportation issues that span GTHA regional/jurisdictional boundaries in consultation with the agencies/jurisdictions involved.

6 Concluding Remarks

Over time, roads and highways have become the backbone of the GTHA's transportation system. At the local level, regional roads play an equally important role as foundational elements of the urban fabric.

Although we now rely on roads and highways for most of our transportation needs, the network has not grown as fast as our population or our economy. Roads have also facilitated the emergence of a landscape of car dependence not unique to this region, resulting in the need for more road capacity. The result is a costly system characterized by congestion and growing emissions. And while our roads are safe, too many of our residents still get injured or lose their lives while driving, cycling or simply crossing a street.

Like the other Green Papers, this document does not purport to bring decisive answers to these major issues, but attempts to identify major issues and potential avenues for discussion and ultimate resolution. This report sets out three alternatives, which include carrying on as currently planned and increasing interventions to build towards a more holistic role for roads and highways in a complete transportation system. Other alternatives and combinations may exist, while new technologies will continue to provide new transportation solutions throughout the coming decades.

As the RTP evolves through public review and technical guidance, the role of roads and highways, and their various possible futures, will be assessed and drawn into a comprehensive and integrated multi-modal transportation strategy for the GTHA.

In order to effectively achieve a sustainable transportation vision, we must incorporate the planning and funding of roads and highways within the broader context of the transportation system. Priorities will need to be identified using common network-wide objectives and criteria that can be applied to all modes and aspects of our transportation system. This approach will encourage greater collaboration among different levels of government and industry stakeholders.

A promising concept is the approach in which roads and highways are planned, designed, prioritized and funded as elements of a comprehensive and sustainable transportation system. This approach will bring discipline and effectiveness to addressing the multi-faceted challenges facing roads, including congestion, collisions, network gaps, rising emissions and impacts on local communities.

It is only through extensive dialogue with all stakeholders, including provincial ministries, municipalities, transit agencies, industry representatives, and members of civil society and the public, that we will define what role roads and highways will play in the sustainable transportation system and society that we want.

Appendix A: Roads and Highways Best Practices

Best Practices for Arterial Roads and Regional Streets

"Tidal Flow" Operations

Arterial street capacity is often inadequate to satisfy demand. Where additional vehicular capacity is desired, it is sometimes possible to alter the lane direction to provide it. A local example is Jarvis Street in Toronto, which is five lanes wide and operates with three lanes in the peak direction (southbound in the morning and northbound in the afternoon) by way of a simple set of overhead lane control signs. Essentially, the centre lane is reversible. There are several examples of Tidal Flow operations around the world. Some facilities (e.g. Centre Street, Calgary; Champlain Bridge, Ottawa) use the "extra" peak direction lane for HOVs.

Picture 8 : Jarvis Street's centre lane is reversible.

Contraflow Lanes

Contraflow lanes are peak period lanes borrowed from the opposing direction. This can be an extraordinarily cost-effective way of creating additional peak period capacity in a physically constrained environment. Careful operational design and ongoing management is needed, and traffic conditions in the counter-peak direction must be such that the loss of a lane during peak periods can be accepted. Left turns in either direction become difficult to accommodate and intersection operations become more complex, so ideally the fewer intersections involved the better. The contraflow lane itself can be restricted to certain types of users (e.g. buses, HOVs) in order to limit the volume, provide a queue-jump benefit to users, and manage intersection operations.

Examples of contraflow operations include the Champlain Bridge in Montréal, the Kapiolani, Kalanianaoli, and Nimitz routes in Honolulu, Spring Street in Los Angeles, and various downtown Minneapolis streets.

In central city conditions, contraflow lanes are sometimes implemented on one-way streets, to allow access to mid-block sites or to allow buses to make connecting moves. In the U.K. and Montréal, contraflow bicycle lanes are used to create more direct bicycle routes within an otherwise restrictive one-way environment. In all contraflow situations, the unusual nature of the traffic operation requires careful attention to be paid to pedestrian crossing and safety needs.

Intersections

The critical points in the urban street system are intersections, where limited time and space must be shared between crossing and turning vehicles, transit stops/operations, cyclists and pedestrians. Despite constraints, there are examples of alternatives to conventional traffic signals.

Continuous Flow Intersection

Continuous Flow Intersection (CFI) design provides increased left turning capacity, reduced overall delay, and improved safety (due to fewer conflict points). It reduces a wide intersection approach into shorter crossing segments for pedestrians. CFIs have begun to be used at major intersections in the United States in lieu of more costly grade separation solutions.[1]

Diverging Diamond Interchange

A Diverging Diamond Interchange is an innovative way to move traffic through an arterial / expressway interchange. It increases capacity, reduces property requirements, improves safety, and reduces cost compared to conventional layouts. They are rare in practice, but have been used in selected amenable situations.[2] The concept was considered for the Rathburn Road interchange during the Highway 427 Preliminary Design study (2006) but was found to be unnecessary; a conventional diamond was adequate for the demands in that case.

1 Continuous Flow Intersection Recently Opened in Salt Lake City", Urban Transportation Monitor, p. 3, Sept. 28, 2007
2 "Missouri DOT Plans First "Diverging Diamond" Interchange in U.S.", Urban Transportation Monitor, p. 1, April 14, 2006

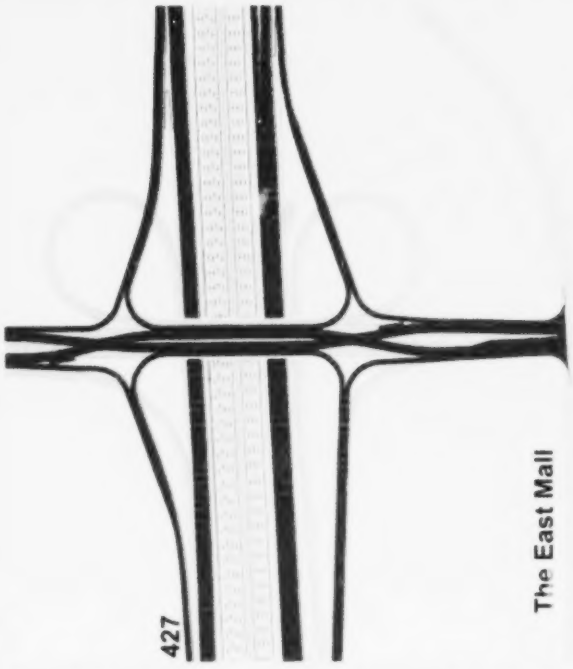


Figure 2 : The diverging diamond concept was explored for Hwy 427 Interchanges and Roundabouts.

Source: McCormick Rankin Corporation

Roundabouts

On a global scale, roundabouts are not innovative, they are proven and in use at thousands of intersections worldwide, but they are relatively rare in the GTHA. Their space requirements make them difficult to retrofit in many locations, and high-volume situations typically do not yield the incremental benefits over conventional signalized intersections that would warrant the costly replacement of existing infrastructure.

However, there is no reason not to consider roundabouts in new roadways, with the prospect of improved vehicular safety, increased capacity, reduced delay, and reduced emissions. The New York State Department of Transportation, for example, recently determined that (when feasible), roundabouts "should be considered the Department's preferred alternative due to the proven substantial safety benefits and other operational benefits".[3]

Special consideration, though, must be given to roundabout design and operation to avoid creating problems for cyclists and pedestrians.

Intelligent Transportation Systems

There is much potential for further application of Intelligent Transportation Systems (ITS) to arterial roads — red light running cameras are already in use, as are traffic signals activated by approaching buses and emergency vehicles. "Smart" parking facilities in some cities can keep track of space availability and guide motorists to open spots, thereby reducing unnecessary circling around to seek a spot. Advances in safety systems (for example, intersection collision avoidance systems), automated occupancy detection systems (for determining eligibility of vehicles for HOV lane or priority parking space use), and traffic signal timing on the basis of person throughput rather than vehicle throughput are examples of the innovations currently in the research stage.

Streetcar / LRT Treatments

Rail lines have long used street corridors in the GTHA, with the Metropolitan Street Railway Company operating along Yonge Street from 1896 to 1948. However, streetcars, LRT and arterials have an uneasy co-existence, as they compete for time and space within an established corridor.

Conventionally, LRT tracks occupy the middle two lanes and are flanked by two directions of traffic. This requires passengers to cross to the median stop, introduces delay at intersections, and restricts many auto turning moves. Furthermore, few arterials in the GTHA have protected broad medians suited to retrofitting LRT lines, requiring difficult tradeoffs to be made between public transit, other road users, and the adjacent properties.

On the other hand, putting LRT routes in corridors that are available (e.g. hydroelectric transmission corridors) would allow faster operating speed with fewer crossing and pedestrian conflicts, but would distance the service and stops from the origins and destinations of many potential passengers. Such unintended uses for utility corridors can also trigger costly and difficult measures to resolve conflicts with the above- and below-ground utilities already present, not to mention the expected concerns among adjacent residents about new and unexpected uses of what is currently "open space".

3 See http://www.modot.org/tsc/2007documents/RoundaboutsFirstPolicy.pdf

An alternative that may result in a better outcome for transit passengers, motorists, and pedestrians is to operate the transit line on one side of the road and general traffic on the other. Rather than a four-lane road split in two by a two-lane transit line, this alternative sees a four-lane road sitting beside a two-lane transit line. Transit stops become more flexible in location, the transit lanes can be designed as an extended sidewalk, and there is less risk of conflict between the modes. This concept is in common use in Europe (e.g. Prague) and has been introduced to plans for Cherry Street in Toronto.[4] Obviously, careful urban design, intersection operation, and shop delivery access is required.

Best Practices for Managing Capacity – Expressways

Retrofitting Additional Capacity

In mid-2006, a reversible express roadway (three lanes wide) was opened on the Crosstown Freeway in Tampa, Florida. It uses open road tolling (similar to 407 ETR) and allows users to bypass five kilometres of severe congestion, inbound in morning peaks and outbound in the afternoon. The express lanes nearly double the peak direction capacity of the expressway. The 20 metre-wide express roadway is elevated above the existing expressway and rests on a series of two metre-wide piers constructed in the expressway median.

Reversible Lanes

Many highways exhibit a highly directional traffic flow — inbound each morning and outbound each evening. In some situations, the road authority may be able to allocate the road space in proportion to the demand by employing reversible lanes. For example, a lane that operates in one direction during part of the day and in the reverse direction at other times, in accordance with traffic demand. Reversible lanes tend to be separated by barriers (permanent or temporary/moveable) from opposing traffic. They are sometimes made available only to HOVs or buses. There are a few examples of reversible highways, in which the entire roadway operates in one direction at a time.

Picture 9 : Contraflow HOV lane in Dallas.

The main benefit of a reversible operation is that maximum use can be made of existing infrastructure without having to widen — a six-lane road can carry as much traffic during peak periods as an eight-lane road. This is only feasible, however, under certain operational, geometric, and configuration situations. It is an attractive option at choke points such as tunnels and bridges.

The only such dynamic operation in the Toronto area is on Jarvis Street in Toronto, where the five lanes operate with three lanes southbound in the morning and three lanes northbound in the evening.

Moveable Barriers

Moveable barriers are used by the Ministry of Transportation of Ontario (MTO) in construction zones to create safe work envelopes on a temporary (overnight) basis. Elsewhere, however, they are used in permanent installations to create additional traffic capacity within restricted rights-of-way in peak directions during peak periods. Several of the reversible lanes noted above are created on a daily basis with moveable barriers.

Another application is being developed on Highway I-15 in San Diego, where a four-lane median roadway is being built with a central moveable barrier to create one, two, or three High Occupancy Toll lanes in either direction according to traffic demand.

Moveable barriers allow contraflow lanes to be operated in a safe and secure manner, by ensuring that there is always a physical barrier between opposing flows. They have been applied in all weather conditions and climates. Moveable barriers do not readily accommodate intermediate access and are suited only to controlled-access divided highways.

4 See http://www.ttc.ca/postings/gso-comrpt/documents/report/f3437/Streetcars_on_Cherry_Street_and_Sumach_Street_Serving_the_West_Don_Lands_Development.pdf

Driving on the Shoulder

As congestion has increased, pressure has increased to use all available space. Most expressways and some urban roads have broad-paved shoulders, provided for safety reasons. In situations in which the road agency judges that the potential value of increased throughput outweighs the reduction in safety, the shoulder space can be used as a traffic lane during peak periods. Since shoulders are not normally built to the size and strength required to carry moving traffic, reconstruction is usually a prerequisite.

Nevertheless, the UK has moved in this direction (e.g. on M-42), and Highway I-95 near Washington D.C. permits the shoulder to be used by traffic during peak periods.

A special case of shoulder use is designation for bus-only operation during peak periods. In Ontario, Road 174 in Ottawa and Highway 403 in Mississauga offer examples of this practice. Bus use of expressway shoulders is a standard practice in the Minneapolis interstate network, and other projects are in operation in San Diego, Atlanta, Washington D.C., Auckland (NZ), Melbourne (AU), Utrecht (NL), and elsewhere. In most cases, there are severe restrictions on bus operating speed and conditions of use, but Ottawa demonstrates the practicality and benefit of unrestricted bus operations. By providing a queue-jump function for buses during peak congestion times and locations, "Bus Bypass Shoulders" (BBS) offer passengers a faster, more reliable trip, and allow bus operators better fleet management and scheduling.

Picture 10 : Bus Bypass Lane.

High Occupancy Vehicle Systems

High Occupancy Vehicle (HOV) lanes that are limited to use by buses and private shared-ride vehicles are being used successfully on Highways 403 and 404, and the practice is widespread across Canada, the U.S., Australia, and now the UK. More than simply considering the corridor function of an HOV lane, the real benefit comes from providing an HOV-only expressway network equal in scope to the underlying general road network. This entails continuous HOV lanes on most, or all, of the expressway network, with direct expressway-to-expressway HOV links and HOV-only ramps to crossing streets, and connectivity between arterial HOV lanes, off-line transit facilities, and expressway HOV lanes.

A few U.S. centres have put significant expressway HOV lane networks in place (Washington, D.C. area, Seattle area, Los Angeles area, San Francisco Bay area, Houston, Dallas, Phoenix, etc.) while others have several standalone HOV facilities (e.g. New York City, Miami, Boston, etc.) that do not interconnect.

The Los Angeles and Seattle areas have developed connections between crossing HOV facilities, and work continues to retrofit HOV ramps and intermediate access opportunities in several locations.

Washington State and the municipalities and transportation agencies in the Seattle area have combined arterial HOV measures and support programs (carpool parking priority, Guaranteed Ride Home, Park-and-Ride lots, vanpooling services, transit hubs tied into HOV lanes) to create an integrated HOV program founded on an extensive expressway HOV lane system. Although still incomplete, this integration of public transit and private shared-ride infrastructure and programs is perhaps the most relevant HOV "best practice" for the GTHA.

The Los Angeles HOV network is more infrastructure-based with a less integrated support framework, while the HOV program in Texas is evolving towards a Managed Lanes road pricing situation. HOV lane violation rates in southern California are kept low by way of good legitimate HOV use and fines that can amount to several hundred dollars (escalated for repeat offenders, and posted on the highway).

Picture 11 : Highway 403 HOV lanes opened in December 2005.

Picture 12 : Different functions competing for use of the curb lane on Toronto's Bay Street; access restrictions need to be enforced to be effective on an arterial.

Park-and-Ride Lots / Carpool Parking Lots

The Ministry of Transportation in Ontario (MTO) has created dozens of free parking lots along GTHA highways, and selected lots are being upgraded to accommodate transit service. Creating ramps to get buses and carpools on and off the adjacent highway quickly and efficiently is part of the program. These facilities make it easy for rural and suburban commuters to travel between their homes and a common gathering place, then to travel by more cost-effective, efficient and environmentally-friendly modes (carpool, transit) to their destination. When combined with HOV lanes along the route, this creates a potent incentive to not drive alone. Transit service to the lot makes it even easier to choose a shared-ride mode, while the concentration of passengers at one site allows transit operators to focus on the most efficient part of the service — the drive.

Picture 13 : One of MTO's numerous free carpool parking lots.

Speed Enforcement

Despite the political issues around photo speed enforcement programs, there is no question that they can be effective at reducing speed and improving road safety. Their presence is generally cited as resulting in a 10-20 per cent reduction in traffic collisions. The associated reduction in cost to society (medical, insurance, property damage, personal injury, etc.) substantially exceeds the cost of implementing and operating the program. Fixed-location speed cameras are in widespread use in Europe and Australia, as well as in the U.S., and provinces such as Alberta and British Columbia.

Access Restriction

During peak periods, the first locations to trigger a breakdown in through-traffic flow on an expressway are usually entry ramps. Ramp metering can help manage the flow of traffic using an entry ramp, but outright closure of selected ramps during peak periods can be the most effective means of maintaining highway throughput. For instance, the closure during afternoon peak periods of the entry ramp to the westbound Gardiner Expressway from Jameson Avenue in Toronto yields a safer, more effective highway operation.

The exclusion of commercial vehicles from the express lanes of the New Jersey Turnpike (configured similarly to Toronto's Highway 401) allows those lanes to operate at higher speeds and with greater throughput than they otherwise would. Access restriction is the key to managing barrier-separated HOV / HOT facilities such as on Highway I-15 in San Diego.

On an arterial, access by certain modes or functions (deliveries, garbage pickup, and commercial vehicles) may be permitted only during off-peak periods to avoid

interfering with buses, cars, pedestrians, and cyclists during their peak times of need. In a similar vein, restricting construction activities to least-disruptive periods and durations is useful.

The design of several U.S. turnpikes that feature long stretches without any interchanges can create a very safe, high-speed, easily-managed facility for inter-city travel with complementary roads for shorter-trip needs. This is in contrast to the tendency in the GTHA to provide interchanges at every opportunity on our arterial grid.

Picture 14 : Seattle ramp express lanes open to transit and carpools only.

Land Use Integration

Expressways are physically and functionally incompatible with most human-scale land uses. Safety, noise, cost, air quality, accessibility, and other factors make it far more difficult to integrate high-standard roadways into the urban fabric than other elements of the transportation system. Nevertheless, there are situations in which the road authority has made an effort to integrate transportation and land use:

- Highway I-5, Seattle Freeway Park
  - A major downtown expressway is not concealed from sight, but the air space above it is transformed into a significant public amenity, with waterfalls and terraces to block the traffic noise
  - A nearby elevated segment of I-5 has a park underneath it, incorporating an off-leash dog area, a mountain bike track, and pedestrian routes
- Ramp to HOV lane through building, downtown Seattle
  - Expressway ramps need not always be wasteful of urban space
- Franklin D. Roosevelt Drive, Manhattan
  - A park and three roadways share a difficult, scenic site
- HOV parking garages, Highway I-35W, Minneapolis
  - Carpools have an express trip to downtown, priority parking, and elevated walkways to office buildings
- Décarie Expressway, Montreal
  - Depressed roadway allows retention of local street grid
- Spiral bridge approaches, China
  - Compact urban form despite scale of roadworks

Truck Lanes

The value of the highway system for goods movement cannot be overstated. Peak period congestion, toll routes, and network gaps increase shipping costs. Priority measures for trucks are, however, relatively rare. Heavy trucks are often restricted from particular highway lanes and from urban roads in residential areas. Recent initiatives bear watching.

Truck climbing lanes on several southern California highways and Highway I-5 features a long truck-only lane to allow those vehicles to bypass the congested Highway I-405 interchange area. Plans are underway to implement truck lanes on other interstates with heavy truck usage (e.g. Highway I-710).

Truck-only Toll (TOT) lanes on Highways I-285 and I-20 in Atlanta are privately constructed tollways in existing highway corridors, to be partially funded by toll revenue.

South Boston Bypass Road is dedicated to commercial vehicle use and draws traffic away from congested Highway I-93 through central Boston.

Intelligent Transportation Systems

The use of electronic systems to monitor and manage the flow of traffic on major routes is commonplace; MTO's COMPASS system is one example. Most road authorities in the GTHA have traffic signal control systems and control

centres, and some have access to roadside cameras. In parallel with the emergence of such Intelligent Transportation Systems (ITS), the auto industry has been making vehicles "smarter", a trend that will likely continue in the foreseeable future.

Once free-flowing highway traffic comes to a halt, it can only begin flow again at less than three quarters of its capacity, and the queue will not be cleared until the incoming traffic flow drops to less than the queue release rate. This may be hours later, which is why the congestion remains long after the incident has been removed.

When more than 50 per cent of the traffic congestion on today's expressways can be tied to collisions, blocked lanes, "rubbernecking", and secondary accidents (when a collision occurs at the end of the queue that forms after an initial incident), ITS provides value in both managing flow to reduce the risk of collisions, and in rapidly identifying and removing any incidents that do occur. Of all the solutions available to get more vehicular capacity out of existing infrastructure, ITS tools are among the most cost-effective, practical, and promising.

The use of ITS to prevent or reduce collisions is another area of current focus. Vehicle collision avoidance systems, lane departure warning systems, driver fatigue monitoring systems, queue warning signs, and heads-up displays are all available and continue to grow in use and effectiveness.

The pace of implementation of widespread ITS measures is slowed somewhat by cost, market conditions, the inability to fully integrate private vehicle-based and public road-based systems, the inability to retrofit the entire vehicle population with new systems, privacy concerns, technology problems, and the lack of demonstrable benefits to the implementing agency. Nevertheless, there are systems on the market, in development, or with the potential to make a dramatic impact on vehicle use of roads and highways. Some of the most effective existing systems focus on safety (e.g. in-vehicle "following too closely" and lane departure warning systems) and user information (e.g. trip-planning and congestion presence advice).

Basic ITS tools such as ramp metering (as used on the Queen Elizabeth Way (QEW) in Mississauga) can have some impact on highway capacity, as have incident response teams (triggered by flow-monitoring algorithms and closed-circuit television monitors). Demonstration projects have been undertaken, showing a "train" of vehicles tied together electronically bumper-to-bumper, and moving quickly and smoothly with "hands-off" control. While feasible, these systems are not yet in use. Their implementation will likely begin with barrier-separated Managed Lanes, where selected vehicles fitted with the appropriate devices can operate. The opportunity to increase the throughput of a lane by 50 per cent or more and to reduce delays and collision risk is an attractive inducement.

Another approach to increase highway person-carrying capacity is to use ITS tools to make ride-sharing and transit use more convenient and attractive — for example, instant electronic ride matching, "next bus" information sent to mobile phones, Smart Card cashless fare payment, and so on.

Active Transportation

Highway corridors are not just for cars and trucks; they can also be used by people walking, bicycling, blading, or using other forms of active transportation, either for commuting or for recreational purposes. To have such varied forms of transportation co-exist in a safe and functional manner, however, requires special attention to physical separation and operating rules.

Corridor rights-of-way must be wide enough to accommodate other users. Building a safe, accessible, grade-separated linear path can potentially involve significant costs at highway interchanges.

Even high-speed multi-lane highways can support active transportation by providing corridor opportunities for path continuity across topographic obstacles — for example, the QEW in Mississauga crosses the Credit River in the middle of a seven kilometre gap in the arterial road network; cars can use the existing bridge but cyclists and pedestrians cannot. A highway structure that accommodates both highway and active transportation modes would benefit personal mobility across a large area.

Picture 15 : In Hamilton, one lane of arterial traffic was converted to a two-way bike path, allowing cyclists to safely cross Highway 403.

Construction and Maintenance

A significant contributor to road delay and disruption is the on-road activity required to repair, maintain, and improve roads and bridges. Although more difficult to schedule and costly to undertake, the Ministry of Transportation of Ontario makes a great effort to conduct roadworks outside of peak travel demand periods, and to minimize the impact on vehicular throughput and safety when there is no alternative but to work during peak periods.

In addition, innovative processes aimed at speeding up repair work and bridge replacements have been developed in recent years and are being applied in Ontario. In August 2007, for example, a pair of obsolete bridges carrying Ottawa's central expressway over Island Park Drive was removed and replaced using Rapid Replacement technology. The new bridges were built nearby, the old bridges were cut out, and a set of precision-guided self-propelled transporters picked up the old bridges, rolled them out (for subsequent demolition and recycling) and slotted the new ones in. The expressway was reopened to traffic after a mere 17-hour closure (overnight on a weekend), avoiding two years of congestion impact that would have been associated with conventional bridge replacement techniques.

Best Practices for Road Pricing

Some of the greatest advances in urban transportation in recent years have come from the application of dynamic pricing tools to the road system. The purposes of using pricing are many, but it comes down to two basic objectives: to shape or manage motorist behaviour so that the road system operates as efficiently and effectively as possible; and to raise funds, either out of necessity or as a matter of public policy (i.e. "user-pay").

The use of conventional stop-and-pay toll booths is dwindling and does not represent best practice.

Road pricing has, to date, focused on high-volume Controlled Access Highways, for both logistical and financial reasons. Issues of access and equity may arise with tolled facilities, due to their functional integration in an otherwise toll-free roads and highways system.

Toll roads were common in the GTHA in the mid-1800s, as private road companies were encouraged to form and extend the road system. Islington Avenue, for example, was a private toll road from Albion Road to Kleinburg. Public protest and attacks on toll booths in the 1890s prompted the shift of all roads to public agencies.

Open-Road Tolling

Highway 407, Melbourne CityLink, Cross-Israel Highway, and Santiago, Chile motorways all feature open-road tolling (i.e. no stopping to pay a toll). All vehicles using the road are recorded by either a transponder or a camera, and the registered owner is later invoiced a per-use and/or a per-distance fee. The revenue is applied toward the capital and operating cost of the facility.

This approach to toll highways is gaining traction in the U.S., both as a replacement for conventional toll booth facilities and as a funding mechanism for new highways. For example, the Massachusetts Transportation Finance Commission has recommended phasing out toll booths on the Massachusetts Turnpike, and eventually moving to a per-mile charging system for all highways in the state.

Shadow Tolling

Shadow tolling allows the private sector to get involved in the financing and operation of a roadway while avoiding the need to introduce user-pay cost-recovery systems such

as motorist tolls. Instead, the government pays the private operator a fixed fee per user (essentially paying the toll on behalf of the user).[5] This is particularly useful for widening or capacity expansion projects, where there is a high cost but no willingness to retrofit a toll system to the entire roadway to pay for expansion. Based on the reasonably predictable program of toll payment, the private sector can finance the project. The government would then be capable of recovering the shadow toll from motorists by other means (a vehicle licensing surcharge, for example) if it chose.

Shadow tolling was introduced in the UK during the 1990s and has since been applied elsewhere in Europe. It has not yet been used in North America.

Variable Pricing and Dynamic Tolling

The notion of managing demand by raising prices during peak periods is analogous to how many other municipal services are provided. Even ice rentals at GTHA arenas vary in price by the hour, to promote off-peak use and suppress peak period demand to match available capacity. The concept of using toll rates that change on a minute-by-minute basis to either attract or suppress demand for a toll route has gained attention now that the technology that combines real-time performance monitoring, predictive operations algorithms, and electronic tolling has been developed and proven in practice.

A classic example of variable pricing is Expressway SR-91 in the Los Angeles area, where a 16 km long four-lane limited-access toll highway lies in the median of a congested general purpose expressway, and the toll rate varies from $1.20 to $10 on a fixed (pre-defined) schedule according to time of day and other conditions.[6] The current toll rate is posted on electronic signs in advance of the access point.

Dynamic tolling, for which rates vary according to operating conditions, is in place on the express lanes on Highway I-15 in San Diego.[7] There is a basic schedule-based toll rate, varying from $0.50 to $4, but rates may go to $8 at times of severe congestion.

Expressway SR-91 offers a reduced fee for carpools, while HOVs travel free on the I-15 express lanes (they must pass through a visual inspection area to bypass the electronic toll transmitter).

High-Occupancy Toll Lanes and Managed Lanes

Two types of lanes combine tolling with HOV benefits:

HOT lanes — HOV lanes that allow a limited number of non-HOVs to pay a toll to use available lane capacity (i.e. to maximize the number of people carried in the lane) — and toll lanes that provide a free or reduced-toll service for HOVs (i.e. to maximize toll revenue while accommodating HOV policy). These facilities fall into the general category of Managed Lanes.[8]

In the first case (e.g. Highway I-15 in San Diego or Highway I-394 in Minneapolis) the objective is to fill the lanes with HOVs and gradually eliminate space for non-HOVs. With limited revenue generation potential (since the least capacity is available to toll-paying vehicles during the periods of peak HOV demand) and HOV demand growth, this strategy can be used to develop a long-term HOV lane plan or to preserve an under-performing HOV facility.

In the second case (e.g. SR 91 Express Lanes, Los Angeles), the objective is to fill the lanes with toll-paying users and limit the number of off-price users (for instance, by raising HOV eligibility to three or more people). This is a step towards a revenue-generating toll road / lane system, which addresses some social policy goals, such as the promotion of carpooling.

Highway 407 ETR does not provide any HOV toll discounts, and car-pooling proportions on 407 are at or below the average of thoes of the other GTHA highways.

Truck Tolling

Allowing large trucks access to HOV lanes has been deemed to be incompatible with the objectives of speed and reliability. Highway I-25 in Denver, CO, provides a rare example of truck use of a HOT facility, but even there the surcharge for truck access is substantial ($18 per trip) in order to avoid truck use interfering with bus and car-pool operations.

5 See http://www.fhwa.dot.gov/ppp/dbfo_shadowtoll.htm
6 See http://www.91expresslanes.com/#
7 See http://www.sandag.org/index.asp?classid=29&fuseaction=home.classhome
8 See http://ops.fhwa.dot.gov/freewaymgmt/managed_lanes.htm

The Atlanta area has proceeded the farthest with the development of plans for a network of Truck-Only Toll (TOT) lanes.[9] It is recognized that tolls alone do not provide sufficient funding for truck-only facilities.

The Port of Long Beach, California, served by the clogged Highway I-710, introduced a traffic mitigation fee program to induce container truckers to access the port outside peak hours. Within one month of the introduction of the $40 - $80 peak period fee introduction, of one-third of container cargo had shifted to off-peak times, thereby freeing up capacity and improving road operations throughout the day.[10]

Fast and Intertwined Regular (FAIR) Lanes

This is a refinement of the Managed Lane principle, whereby those motorists who pay a toll get better service (in the form of a congestion-free Managed Lane), while those who do not use the Managed Lane get a form of financial compensation. Although no FAIR Lane projects are yet in operation, the U.S. Federal Highway Administration has included a FAIR Lanes study in its current Value Pricing Pilot Program.[11]

A FAIR highway would be divided into "fast" lanes and "regular" lanes, separated by some form of barrier. Fast lanes would be electronically tolled express lanes, with tolls set in real-time to limit traffic to the free-flowing maximum. Regular lanes would be free, but would likely be more congested than fast lanes. Drivers who use the regular lanes during rush hours would be given credits that could be used as toll payments on days when they choose to use express lanes. The credits would compensate drivers for giving up their right to use lanes that they "have already paid for," and for any added delays that may result.

The FAIR strategy aims to overcome the negative public perception associated with converting a non-tolled general-purpose highway into a toll facility.

Area-Based Congestion Pricing

The intent of a Congestion Pricing scheme is to use financial incentives and disincentives to influence mode choice and travel patterns in a corridor or locality, so that private auto use is curbed and more people use alternative modes. This approach is viable in situations in which unmanaged private auto use results in severe economic and environmental consequences. Congestion Pricing can be used on a roadway or, more commonly, on a cordon around a crowded Central Business District (CBD).

The highest-profile application of area-based congestion charging is in central London, England. Introduced in February 2003, a flat fee applies to all motorists who enter central London, as defined by a cordon line around the area. The immediate impact has been a reduction in traffic within the cordon, an increase in road safety, an increase in the use of transit, cycling, and walking, and the generation of significant new revenues for re-investment in transport projects and services. The zone was extended to nearly double the original size in February, 2007.

Stockholm, Sweden launched a similar cordon-based pricing scheme in January, 2006, the initial impact of which was to reduce CBD traffic volumes, increase transit usage, and cut traffic congestion significantly. In September, 2006, a local referendum regarding the scheme was held.[12] In the City of Stockholm, more than 50 per cent voted for retention, while the surrounding counties voted 60 per cent against the scheme. Based on the benefits observed, the government decided to make the scheme permanent.

Other cities (including New York, San Francisco, Singapore, Bergen (Norway), and Valletta (Malta)) have either implemented or are considering implementing a congestion charging scheme. The net funds raised by congestion charging are normally re-invested in urban transport improvements.

Another variation of this concept is "Environmental Pricing", whereby vehicles which operate in zones of low air-quality are charged a fee, aimed at discouraging high-emission vehicle use (and auto use in general). The cities of Milan, Rome, Turin, Berlin, Cologne, Hanover, and London are among the major European centres implementing such programs.

Distance-Based Pricing

Another non-intrusive pricing strategy that aims to both ensure that heavy road users pay "their fair share" and reduce overall auto use is distance-based pricing. Rather than a fuel tax, which varies in effectiveness according to the fuel efficiency of the particular vehicle being driven, or a toll that affects only users of a particular route, distance-based pricing simply translates an odometer

9 Atlanta TOT Facilities Study, PBQD for State Road and Tollway Authority, July 2005
10 "Port Congestion Pricing Reduces Peak-Hour Truck Traffic on L.A. Freeway by 24 Percent", Urban Transportation Monitor, Oct. 28, 2005
11 See http://ops.fhwa.dot.gov/tolling_pricing/value_pricing/projtypes/fairlanes.htm
12 See http://www.stockholmsforsoket.se , http://www.vv.se/templates/page3____17154.aspx

reading into a per kilometre charge for vehicular travel. The rate can vary according to vehicle weight, emissions, and distance-travelled. An electronic cordon can be established so that the fee only applies to travel within the GTHA. As U.S. states seek ways in which to become less reliant on per-gallon fuel taxes for highway funding, there is growing interest in distance-based pricing approaches.

Some auto insurance companies are beginning to offer pay-as-you-drive rates, and similar approaches are being applied to trucks in European countries, such as Germany and Switzerland.

Appendix B: Potential Initiatives

	Initiative
Number	**High-Occupancy Vehicle (HOV) Lanes**
HOV1	• Implement HOV lanes, built through road widening
HOV2	• Implement HOV lanes built from converted lanes
HOV3	• Expand HOV onto more 400-series highways, as well as sections of the Queen Elizabeth Way (QEW)
HOV4	• Increase HOV links between expressway and arterial HOV corridors
HOV5	• Implement HOV lanes municipal roads
HOV6	• Design HOV lanes to integrate transit from the outset
HOV7	• Allow taxis and buses to use HOV lanes on empty return trips
	Transit
T1	• Permit buses to use highway shoulders
T2	• Host separate transit lines, such as bus rapid transit (BRT) and light rapid transit (LRT) on major corridors
T3	• Implement signal priority and queue jump for all BRT systems
T4	• Reconfigure local roads to place greater priority on transit, including bus bulges and other design features
	Road Pricing
RP1	• Restrict road pricing to existing tolled facilities, e.g. Highway 407
RP2	• Increase network of facilities employing transportation pricing
RP3	• Implement comprehensive transportation pricing, incorporating time of use, degree of amenity provided by the infrastructure, parking use, GHG and other emissions
	Infrastructure
I1	• Upgrade active transportation facilities and access in established communities and around transit stations
I2	• Upgrade active transportation facilities and network connections, improving mobility and connectivity between local networks
I3	• Design with concept of "complete streets" on local roads, increasing social space and improving safety through place-making and innovative shared-space techniques, such as "naked streets"
I4	• Implement "clean air corridors", giving priority to active transportation on select routes on smog days
I5	• Invest in structure rehabilitation and maintenance, with localized reconfiguration, and shoulders strengthening and widening for bus use

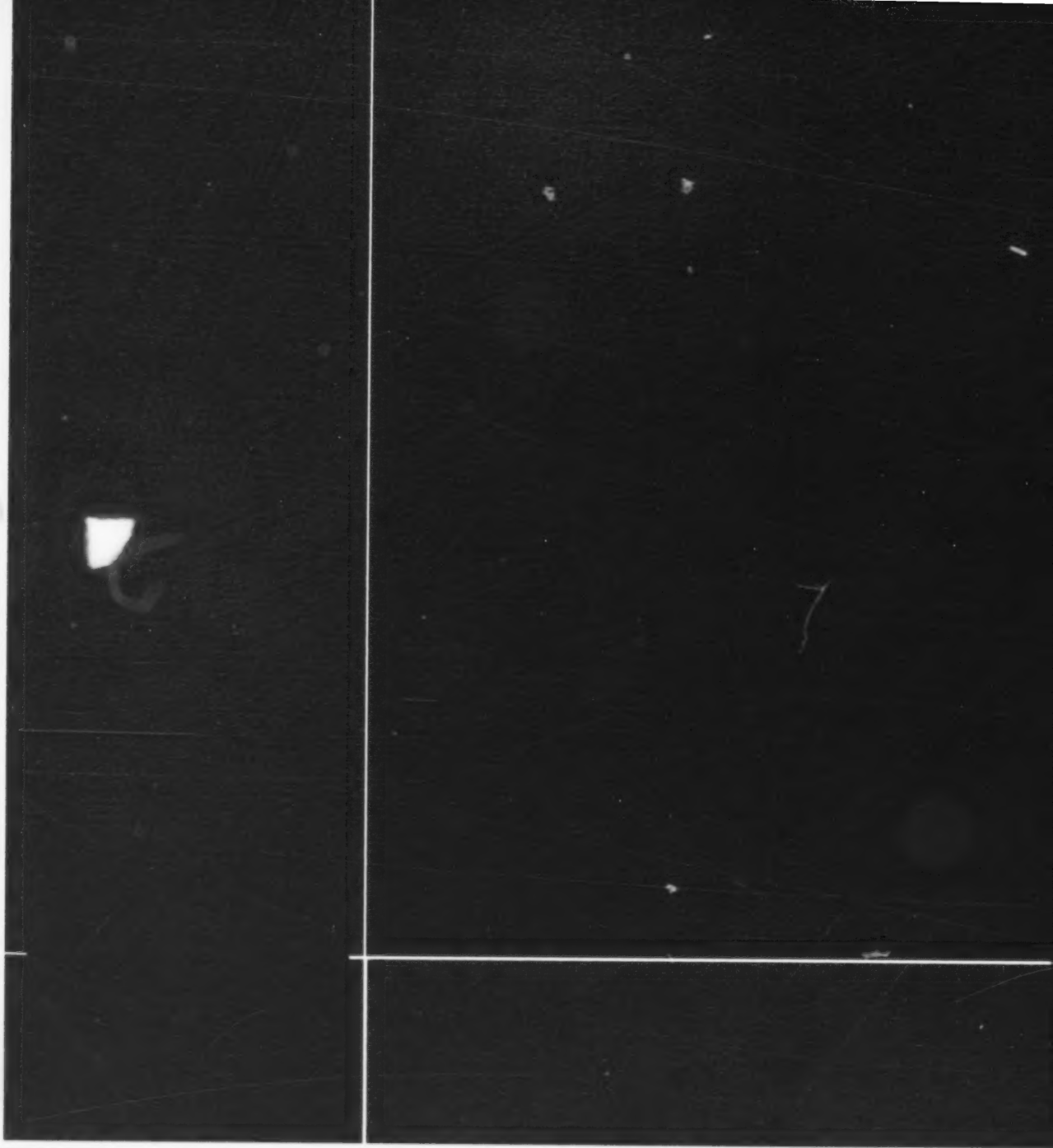
	Initiative
I6	• Assess the need to fill strategic gaps in the road network within the context of the overall transportation system, considering all possible alternatives
I7	• Increase carpool lots and park-and-ride facilities in provincial highway corridors to link carpools, bus services, and HOV infrastructure
I8	• Limit goods movement and service delivery during peak periods
I9	• Restrict goods movement and service delivery in congested areas, combined with development of urban distribution centres
	Information and Technology
IT1	• Create and make available real-time operational information (congestion, weather, price, transit service, ride-matching)
IT2	• Post pricing and travel time information at highway entry points
IT3	• Use ITS tools to optimize commercial vehicle routing and time of travel
IT4	• Embed necessary technologies in all new vehicles and provide aftermarket retrofit kits for current vehicles
	Partnerships and Education
PE1	• Coordinate highway and transit agencies to develop common priorities, pool funds, and co-operate in creating easily accessed transit hubs at key points in the GTHA transportation network
PE2	• Develop education programs to help public become more knowledgeable of the impacts of their daily travel choices and how these choices impact our overall economy, environment and quality of life
PE3	• Encourage individuals to become champions of change and make more responsible travel choices
PE4	• Improve coordination between planning departments to analyze, plan and design elements of the transportation system within the context of an integrated, comprehensive and sustainable transportation system — doing away with remaining "silos"
PE5	• Develop new guidelines, techniques, and design standards to better integrate various modes and priorities
PE6	• Develop and implement financing, zoning, land use planning, and partnership schemes that promote greater integration between land use and transportation

Table 12 : Potential Initiatives.

Appendix C: Photo Credits

Picture 1	Queen Elizabeth Way	S. Schijns, McCormick Rankin Corp.
Picture 2	Buses on arterial HOV Lanes: Don Mills Road	S. Schijns, McCormick Rankin Corp.
Picture 3	Yonge Street 3+ HOV Lanes	S. Schijns, McCormick Rankin Corp.
Picture 4	Freeway lane	S. Schijns, McCormick Rankin Corp.
Picture 5	Incomplete road network	A. Shea, McCormick Rankin Corp.
Picture 6	Redesign of collector for bicycle lanes and parking	T. Gill, McCormick Rankin Corp.
Picture 7	Reversible centre lane on Jarvis Street	S. Schijns, McCormick Rankin Corp.
Picture 8	Contraflow HOV lane in Dallas	HOV Interactive 1.0, Federal Highway Administration/ Parsons Brinckerhoff
Picture 9	Bus bypass lane	S. Schijns, McCormick Rankin Corp.
Picture 10	Hwy 403 HOV lanes	S. Schijns, McCormick Rankin Corp.
Picture 11	Bay Street bus only lane	S. Schijns, McCormick Rankin Corp.
Picture 12	MTO Carpool Lot	S. Schijns, McCormick Rankin Corp.
Picture 13	Seattle HOV ramp	S. Schijns, McCormick Rankin Corp.
Picture 14	Hamilton road diet	Ted Gill, McCormick Rankin Corporation

Table 13 : Photo Credits.



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